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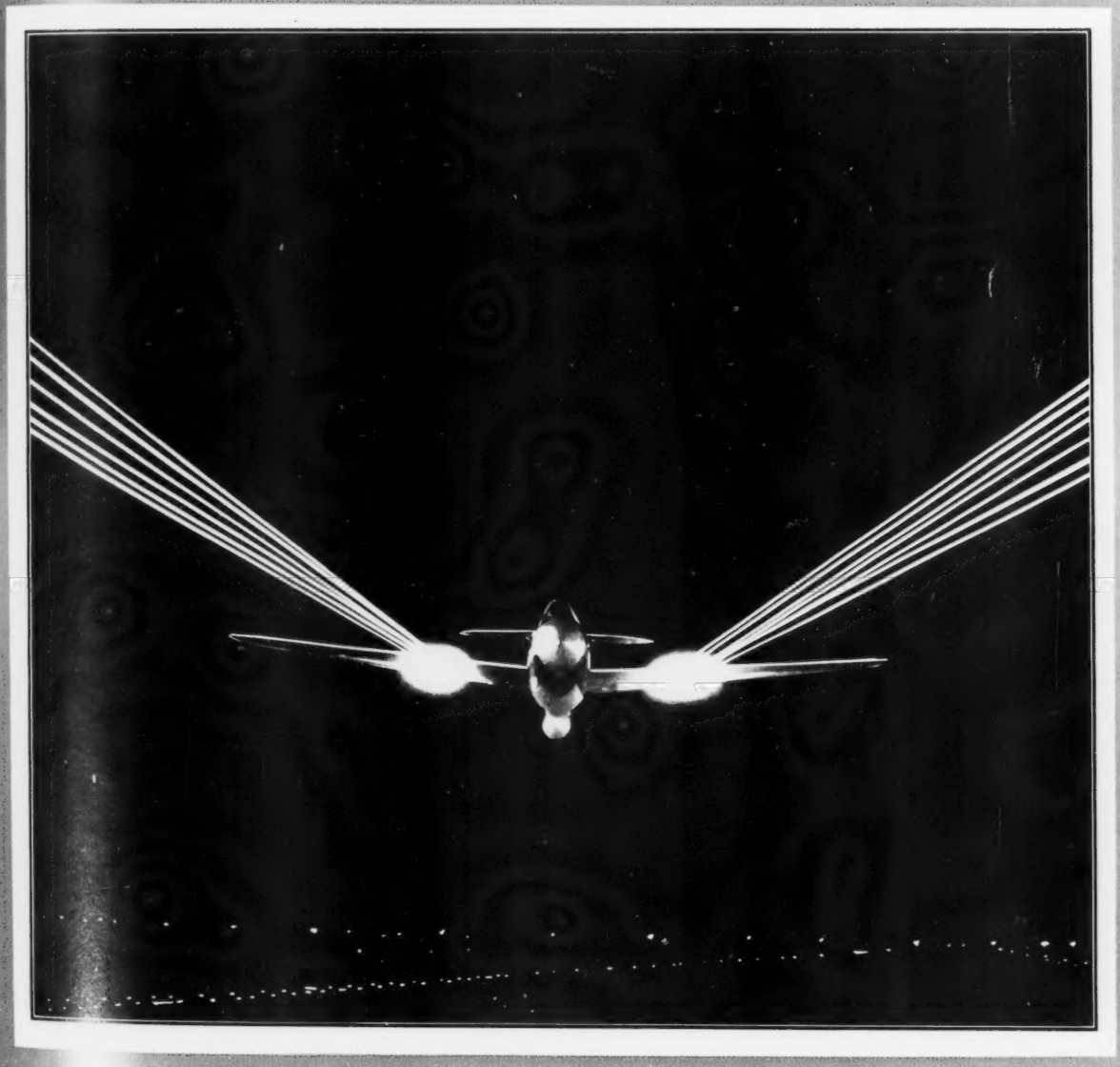

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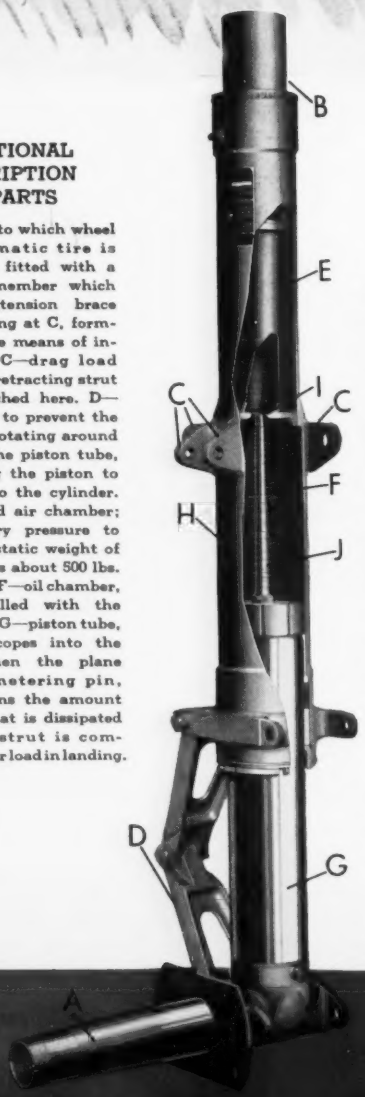

FUNCTIONAL DESCRIPTION OF PARTS

A—stub axle to which wheel with pneumatic tire is fitted. B—is fitted with a supporting member which also has extension brace arms attaching at C, forming a suitable means of installation. C—drag load bracing and retracting strut can be attached here. D—torsion links to prevent the wheel from rotating around the axis of the piston tube, also allowing the piston to telescope into the cylinder. E-compressed air chamber; the necessary pressure to sustain the static weight of an airplane is about 500 lbs. to the sq. in. F—oil chamber, which is filled with the proper fluid. G—piston tube, which telescopes into the cylinder when the plane lands. J—metering pin, which governs the amount of energy that is dissipated when the strut is compressed under load in landing.

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Perhaps, in cold print, this seems like prosaic engineering—but thousands of gallant pilots confidently rely on the unsurpassed efficiency of Aerol Struts.

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AERONAUTICAL ENGINEERING REVIEW

VOLUME 1 JUNE, 1942 NUMBER 3

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SUBSCRIPTION RATES

Aeronautical Engineering Review

United States and Possessions		Foreign Countries Including Canada (American Currency Rates)	
1 Year	$2.50	1 Year	$3.00
Single Copies	0.25	Single Copies	0.30

Journal of the Aeronautical Sciences

United States and Possessions		Foreign Countries Including Canada (American Currency Rates)	
1 Year	$7.50	1 Year	$10.00
Single Copies	0.75	Single Copies	1.00

Notices of change of address should be sent to the Institute at least 30 days prior to the actual change of address.

Publication Office: 20th & Northampton Sts., Easton, Pennsylvania
Editorial Office: 1505 RCA Building West, 30 Rockefeller Plaza, New York, N. Y.
Published Monthly by the Institute of the Aeronautical Sciences Inc.

Entered as Second Class Matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

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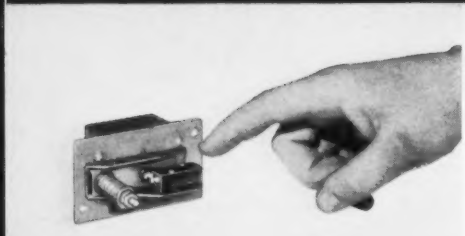

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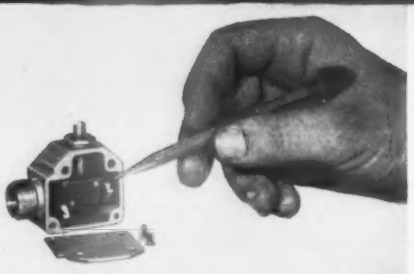

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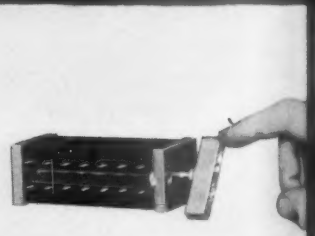

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Aluminum Alloys for Aircraft

T. L. FRITZLEN*

Reynolds Metals Company

ABSTRACT

This paper acquaints the reader with a general knowledge of aluminum alloys and their use, as well as with specific information on commodities used to a large extent in aircraft.

The manufacture of aluminum from bauxite is discussed briefly, as is remelting and casting. The effect of working, alloying, annealing and heat-treating is covered to the extent necessary to give a general picture of these factors. Methods used to determine mechanical properties and definitions of same are given. The temper designations used to identify wrought alloys are explained.

The fabricating procedures, specifications, inspection and uses for (1) sheet and plate, (2) rolled rod, (3) extruded rod, bar and shapes and (4) tubing are presented in some detail.

Aircraft parts ready for protective coatings or assembly are mentioned as being available to the aircraft manufacturer.

Methods of processing are cited briefly, and the paper concludes with remarks as to general considerations in using aluminum alloys.

The main purpose of this paper is to give the aircraft personnel sufficient knowledge to intelligently order, inspect and work these commodities.

INTRODUCTION

TODAY, we are vitally interested in the use of aluminum for fighting and bombing airplanes. The tremendous expansion of aircraft production and personnel has created an unprecedented demand for information concerning aluminum alloys, their behavior, the forms in which they are available, their structural strengths, their inspection and their uses. Since the scope of this paper is necessarily limited, the commodities that will be covered are sheet and plate, aircraft parts, rolled rod, extruded rod, extruded bar, extruded shapes, and tubing.

MANUFACTURE OF ALUMINUM

Aluminum oxide is found in most clays, soils and rocks, but the only ore from which aluminum is produced commercially is bauxite. The ore or bauxite is ground very fine and treated chemically, using the Bayer process[1] to separate it into aluminum oxide and impurities consisting mainly of the oxides titanium, iron, and silicon. Approximately 2 lbs. of bauxite are required to produce 1 lb. of aluminum oxide (alumina).

The alumina, which resembles sugar in appearance, is then broken down into its component parts of aluminum and oxygen. The molten aluminum is tapped from the electrolytic cell[2] and cast into oblong masses termed "pigs" that weigh approximately 50 lbs.

The aluminum pig is melted again for three reasons: (1) to change the shape or form, (2) to add alloying elements, (3) to further refine by removing oxide or electrolyte.

EFFECT OF WORKING ON STRUCTURE

The atoms that make up the aluminum alloy crystal or grain are arranged in the three dimensions of space in a regular manner. The type of atomic pattern, or crystal lattice, determined for aluminum alloys by x-ray investigation is the face-centered cubic structure. X-ray methods of crystal analysis have added considerably to the knowledge of the changes that occur in metallic structures when hot-worked and cold-worked, but the matter is still one of theory and considerable controversy. The two concepts of the structural changes occurring in working or strain-hardening which are most widely accepted are:

(1) C. J. Darwin first advanced the the theory that metallic crystals are made up of small units termed "blocks." Plastic deformation causes slippage along planes within the block, block displacement or fragmentation of the block with subsequent hardening when performed as cold-working; recrystallization effects a new block structure and consequent softening.[3]

(2) Numerous investigators have advanced theories that may be summarized generally—that strain or deformation causes displacement of the atoms from their normal position in the atomic space lattice. Fragmentation of the grain occurs because of the difference in rate of change in lattice dimensions of adjacent grains oriented differently. Both factors tend to harden the metal, but heating to the recrystallization temperature relieves internal strains[4] and causes formation of new grains to create a softer state.

Cast ingots have a structure consisting of grains that vary in shape, size and orientation (direction of the crystallographic axes), depending upon the conditions present during pouring and solidification. This macrostructure, visible to the unaided eye, may vary from round, equiaxed grains to elongated, columnar grains. Generally, a fine equiaxed grained structure is desired. As aluminum alloys are relatively brittle in the cast state and are more plastic while hot, the ingots are extruded and rolled at temperatures ranging from 600° to 900°F. Working at these temperatures is termed "hot-working," while working at room temperature is designated "cold-working." Technically, hot-working is working performed above the softening or recrystallization temperature, while cold-working is that performed below the recrystallization temperature.

The cast structure of an ingot is completely altered by hot-working, such as extrusion or hot rolling, and the grains are changed with respect to both shape and arrangement. A certain minimum reduction in cross-sectional area of the ingot is required to convert the cast structure into a wrought structure. Hot-worked aluminum alloys usually possess a more elongated grain or fibrous structure than aluminum alloys recrystallized or annealed after cold-working. Cold-working also produces a fibrous grain structure, but this is changed generally to a uniform equiaxed structure upon heating to effect proper recrystallization. In hot-working as carried out commercially, the temperature during part of the operation may be below the recrystallization temperature, thereby introducing cold-working with consequent hardening.

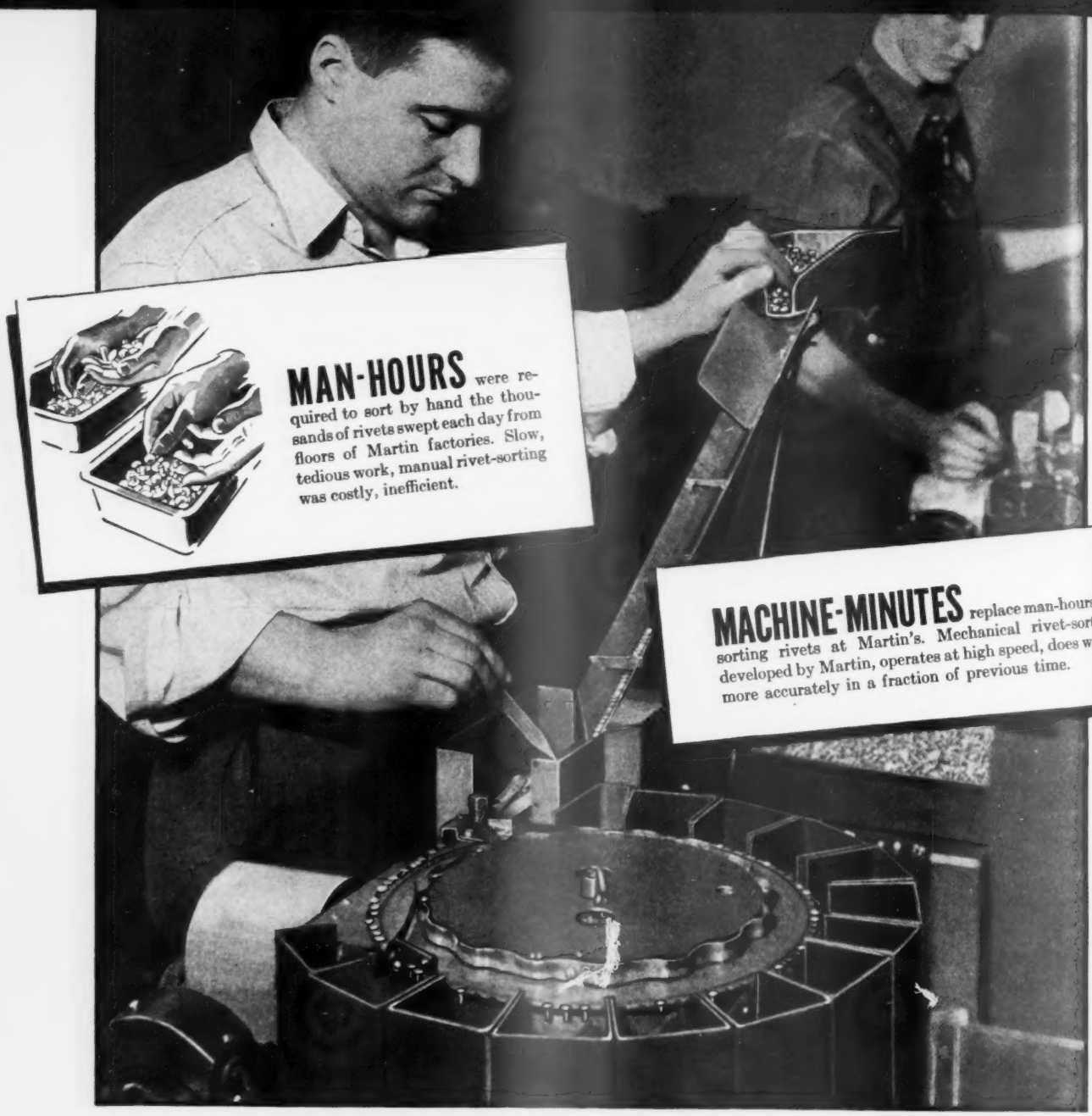
Cold-rolling, cold-drawing, stretching, forming, and bending strain harden the aluminum alloys either by changing the block structure of the crystal or by changing the lattice dimensions of the crystal, depending upon which one of the two theories stated previously is accepted.

ALLOYING OF ALUMINUM

Commercially, pure aluminum (2S), which is approximately 99 per cent aluminum with iron and silicon as impurities, is relatively soft, having about one-fifth the structural strength of mild steel. Elements such as copper, man-

Presented at the Materials Session, Tenth Annual Meeting, I.Ae.S., New York, January 29, 1942.

* Chief Metallurgist.



MAN-HOURS were required to sort by hand the thousands of rivets swept each day from floors of Martin factories. Slow, tedious work, manual rivet-sorting was costly, inefficient.

MACHINE-MINUTES replace man-hours in sorting rivets at Martin's. Mechanical rivet-sorter, developed by Martin, operates at high speed, does work more accurately in a fraction of previous time.

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TYPICAL of the many small devices developed by Martin to save production time, is the Martin mechanical rivet-sorter. This ingenious device takes the accumulation of rivets swept daily from factory floors and separates them according to diameter, head shape, and shank length. Operating at high speed, the Martin rivet-sorter saves much time when compared to tedious, inefficient hand sorting.

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TABLE 1

Nominal Percentage of Alloying Elements*[6]

Alloy	Silicon (Si)	Copper (Cu)	Manganese (Mn)	Magnesium (Mg)	Chromium (Cr)
3S			1.20		
14S	0.80	4.40	0.80	0.40	
A17S		2.50		0.30	
17S		4.00	0.50	0.50	
24S		4.50	0.50	1.50	
25S	0.80	4.50	0.80		
51S	1.00			0.60	
52S				2.50	0.25
53S	0.70			1.30	0.25
61S	0.60	0.25		1.00	0.25

* Balance composed of aluminum and nominal impurities.

ganese, magnesium, zinc, nickel and silicon added to aluminum form alloys of increased hardness and strength. Metals are considered pure in commercial parlance when other elements are not intentionally added to change the properties of the base metal. Alloys of aluminum are composed of crystals of solid solutions and crystals of compounds, depending upon the composition of the alloy. The structural assembly and the characteristics of these crystalline aggregates determine the behavior of the alloy.

Since the atomic structure of crystals has been described to some extent previously, it may be stated that, generally, for aluminum alloys, atoms of the solute replace atoms of the solvent in the space lattice.[5]

Some of the crystals exist in the form of eutectics. Eutectic is a term used to designate the mechanical mixture, of two or more phases, which has the lowest melting point of the particular system. In the case of 17S alloy, embodying several systems, the lowest melting eutectic is considered to consist of aluminum, copper, magnesium and silicon. It has a melting point somewhere between 960° and 970°F. This is considerably lower than the melting point of 1,215°F. of pure aluminum. Therefore, it can be seen that cooling 17S alloy from the liquid state will result, first, in the freezing of aluminum with a certain amount of copper in solid solution, while the eutectics will freeze at a lower temperature. The resultant cast structure appears, when examined under the microscope, to be composed of a background (termed "matrix") of aluminum-copper solid solution with an interspersed network of hard and brittle constituents.

The nominal composition of some of the commercial alloys of aluminum is listed in Table 1.

The strong alloys of aluminum used for aircraft structures are based mainly on the solubility of various elements in aluminum in the liquid and solid states. Some aluminum alloys obtain increased strength primarily through complete solid solubility, while others depend upon increased solid solubility with increase of temperature. The latter type of alloys derive increased strength by heat-treatment, as will be explained later.

ANNEALING AND HEAT-TREATMENT

Annealing, as applicable to aluminum alloys, is a procedure used to soften metal. It is accomplished by heating the metal to a certain temperature to relieve strains; to cause the formation of new grains, termed "recrystallization"; and to cause the reprecipitation in a suitable size of alloying elements that go into solid solution. The exact mechanism of these changes is not fully understood but much has been learned about it through x-ray examinations.[7]

The annealing of cold-worked aluminum alloys consists of heating to a certain temperature, holding at this temperature for a sufficient time to insure that all parts of the load have attained this temperature, and removing from the furnace. The temperature required for 2S, 14S, 17S, 24S, 25S, 51S, 53S and 61S is 650°F.; for 3S, 750°F.

The furnace temperature used for annealing should be such that the temperature of the load can be held to ±20°F. of the desired temperature.

The grain size obtained in annealed aluminum alloy sheet is dependent upon previous thermal treatment and the amount of cold-work that the material has previously received. The rate at which the material is brought to the annealing temperature is a factor in the case of some alloys.

Alfred Wilm made a remarkable contribution to metallurgy in 1909 when he invented the alloy now designated 17S which was then given the trade name "Duralumin" and discovered the fact that a great increase in strength and hardness could be obtained by heating and quenching in water.[8]

The heat-treatment of strong aluminum alloys is based on the fact that the concentration of alloying elements in solid solution in aluminum decreases with decreasing temperature. In other words, copper is soluble in solid aluminum to somewhat over 4 per cent at the heat-treating temperature of 17S, while less than $^1/_2$ per cent copper is soluble in solid aluminum at room temperature. This fact was first determined by Merica, Waltenberg and Freeman in 1919.

The increase in strength is ascribed by Jeffries and Archer[9] to slip interference. If the constituent that is precipitated from solid solution after heat-treatment is considered to be copper aluminide ($CuAl_2$), then these particles, at a certain critical size, are located along the slip planes in such a manner as to key the planes against movement.

These particles of copper aluminide are submicroscopic and, therefore, the theory of precipitation hardening has yet to be proved.

Jeffries and Archer have calculated that an average grain of Duralumin has approximately 2,000,000,000 atoms of copper on each potential slip plane. Assuming an average copper aluminide particle size of one-ten millionth of an inch in diameter they have calculated that the slip plane should be keyed at approximately 35,000,000 to 40,000,000 points.[10]

The procedure employed in heat-treating consists of heating the alloy to the proper solution temperature, soaking at that temperature for a certain length of time, followed by quenching the alloy in water. The heating to temperature, and holding at that temperature, is to effect a solution of the alloying constituents, while the quenching in cold water is to maintain the solution effected. In the case of aluminum alloys the solid solution obtained after quenching is supersaturated and, therefore, unstable. In 17S and 24S alloys, the alloying constituents precipitate from the supersaturated solution at room temperature after a certain length of time, normally considered to be practically complete after four days. In the case of other alloys such as 14S, 25S, 51S, 53S and 61S, precipitation at room temperature is extremely slow, requiring years for completion and, in order to speed up precipitation, these alloys are heated to an elevated temperature, around 300°F., and held at that temperature for a certain length of time. The precipitation part of the heat-treatment is termed "aging" or "age-hardening," while the heating prior to quenching is termed "solution heat-treatment."

The following nominal temperatures are used for heat-treatment:

Alloy	Nominal Heat-Treating Temperature
14S, A-17S, 17S	940°F.
24S	920°F.
25S, 51S, 53S, 61S	970°F.

The soak to employ during solution

heat-treatment depends upon several factors, namely, thickness of material and amount of prior working, the heating-up rate and characteristics of the furnace, and the type of material.[11]

It is important that the material be quenched as rapidly as possible, since the rate of quenching not only affects the mechanical properties of the heat-treated alloy but particularly affects corrosion resistance. Material that has been heat-treated, or partially heat-treated, can be softened by annealing, but the practice required necessitates heating to 800°F., followed by cooling in the furnace to 500°F. at a rate not in excess of 50°F. per hour.

Mechanical Properties

Mechanical properties are defined as the behavior of metal under stress. The application of a stress results in deformation (stretching), which can be permanent or elastic depending upon the magnitude of the stress imposed.

There are three types of stress—namely, tensile, compressive and shearing. In the routine testing of aluminum alloys, usually only tensile stresses are obtained. The material to be tested is blanked, sawed, milled, shaped or turned to make a specimen for testing in accordance with required specification or, as in the case of tubing of smaller diameter, is tested full size.

Typical mechanical properties of the alloys used in aircraft to the greatest extent are given in Table 2.

The tensile and yield strengths increase and the elongation decreases with cold-working, such as rolling or drawing; thus, the need for annealing at intermediate stages during the cold-working operations.

Heating aluminum alloys to elevated temperatures causes a decrease in both yield and tensile strength, with subsequent increase in elongation; cooling to sub-zero temperatures increase both strength and elongation.[12]

The compressive strengths of aluminum alloys are of particular interest in aircraft design due to the compressive stresses to which the structural members are subjected under flight conditions. J. R. Fischel determined the tensile and compressive yield strength, both with and across grain, on high purity aluminum coated (5 per cent each face) 24ST sheet and determined that: the average with-grain yield strength in tension is equal to 1.18 times the average with-grain yield strength in compression; that the average cross-grain yield strength in tension is equal to 0.92 times the average cross-grain compressive yield strength; and that the average with-grain yield strength in compression is equal to 0.97 times the average cross-grain yield strength in tension.[13]

Table 2

Typical Mechanical Properties of Principal Aluminum Alloys for Aircraft

Alloy and Temper	Commodity	Tensile Strength, Lbs. per Sq.In.	Yield Strength, Lbs. per Sq.In.	Per Cent Elongation in 2 In.
17SO	Sheet	27,000	12,000	19.0
	Tubing	28,000	12,000	20.0
	Extrusions	30,000	12,000	18.0
	Rod	30,000	12,000	20.0
Pureclad				
17SO	Sheet	26,000	11,000	19.0
17ST	Sheet	63,000	41,000	20.0
	Tubing	64,000	42,000	18.0
	Extrusions	60,000	40,000	18.0
	Rod	62,000	35,000	25.0
Pureclad				
17ST	Sheet	58,000	36,000	19.0
17S-RT	Sheet	68,000	51,000	15.0
24SO	Sheet	27,000	12,000	18.0
	Tubing	28,000	12,000	20.0
	Extrusions	30,000	12,000	18.0
	Rod	30,000	12,000	20.0
Pureclad				
24SO	Sheet	25,000	11,000	19.0
24ST	Sheet	68,000	46,000	19.0
	Tubing	67,000	46,000	15.0
	Extrusions	68,000	50,000	15.0
	Rod	68,000	43,000	21.0
Pureclad				
24ST	Sheet	63,000	42,000	18.0
24S-RT	Sheet	72,000	55,000	15.0
52SO	Sheet	28,000	14,000	23.0
	Tubing	30,000	14,000	25.0

Note: These mechanical properties are not to be used for guaranteed values. For guaranteed values, refer to applicable U.S. Government Specifications.

Temper Designation

2S, 3S and 52S aluminum alloys are termed common alloys while 14S, A-17S, 17S, 24S, 25S, 51S, 53S and 61S are termed strong alloys.

All of these alloys can be produced in the softest possible state which is as annealed. The alloys that are annealed are designated by an "O"; for example, 2SO, 24SO, etc.

2S, 3S and 52S alloys when produced as hard as possible are designated by an "H"; for example, 2SH, 3SH, 52SH. These alloys are also produced in tempers in between soft and hard such as quarter hard (2S-$^1/_4$H) and half hard (2S-$^1/_2$H).

The strong alloys—namely, 17S, 24S, 53S and 61S—can be heat-treated to produce much harder material. 17S and 24S alloys are designated 17ST and 24ST when heat-treated. 53S and 61S can be produced in two-treated conditions designated "W" and "T," such as 53SW and 53ST. The "W" condition is not so hard as the "T" condition. The "T" condition is produced by heating material in the "W" condition to approximately 320° to 350°F.; this second heating operation is termed "aging."

There is one other condition produced which is the fabricated condition; it is designated by an "F"; for example, 2SF. The "F" is used to designate material in the as-extruded, as-rolled, or as-drawn state.

The "S" designates a wrought alloy, one that is produced by working, rolling, extruding, etc.

Summarizing, we have the following conditions or tempers which are listed in approximate order of increasing hardness or strength: "O," annealed (soft); "F," fabricated (as extruded, as rolled, or as-drawn); "$^1/_4$H," one-quarter hard; "$^1/_2$H," one-half hard; "$^3/_4$H," three-quarters hard; "H" full hard; "W," solution heat-treated (but not aged); "T," solution heat-treated and precipitation heat-treated (aged).

Sheet and Plate

Aluminum alloy sheet and plate (0.250 in. thick or heavier) is fabricated in a variety of gauges, widths, and lengths in all commercial grades and tempers. Two classes of sheet are produced: one is termed "flat sheet" while the other is termed "strip or coiled sheet." Rolling of sheet or plate in the simplest manner consists of passing an ingot, slab, or sheet through two oppositely driven steel rolls arranged

horizontally so that one roll is above the other. The top roll is equipped for raising or lowering to control the thickness of the piece being rolled. The sheets, after rolling to desired gauges, are sheared and annealed or are heat-treated, stretched, flattened and sheared.

Important sheet products in aircraft construction are 17S and 24S covered with an approximate 5 per cent coating or layer of fairly high purity aluminum. This type of sheet is designated "Pureclad" and "Alclad" by the manufacturers. A polished and etched cross section of 0.060 in. thick Pureclad 24ST sheet is shown in Fig. 1. The relatively high purity aluminum coating increases the resistance to corrosion of the strong alloy core to a great extent as is shown by the results obtained in corrosion tests made by W. Mutchler.[14] A brief summary of these results is given in Table 3.

Aluminum alloy sheet and plate is fabricated and inspected to conform to United States Government Specifications. These Army, Navy, and Federal Specifications specify limits for chemical composition, methods of sampling and testing for mechanical properties, mechanical property limits, tolerances for dimensions and straightness, methods of inspection, heat-treatment procedures, preparation for shipment, and methods of identification.

Inspection of aluminum alloy sheet consists of checking grade and temper, dimensions, and straightness, as well as an examination for surface defects such as blisters, slivers, scratches, pits, stains, pinch marks and buckles. Light surface defects or discoloration due to heat-treatment are not considered detrimental.

One type of four-motored airplane having a gross weight of approximately 50,000 lbs. has been estimated by Jackman to contain about 13,500 lbs. of aluminum alloy of which 12,000 lbs. are sheet.[15] The aluminum alloy sheet used for the various parts of this plane was estimated as follows: wing, 7,950 lbs.; fuselage, 2,500 lbs.; tail surfaces, 900 lbs.; landing gear, 100 lbs.; controls and miscellaneous 550 lbs.

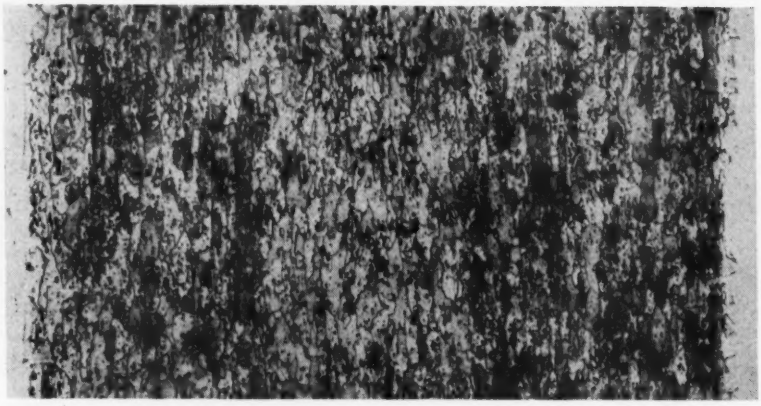


FIG. 1. Cross section of 0.060-in. thick Pureclad 24ST sheet showing surface layers (right and left) of high purity aluminum. Etch HF = HCL = HNO_3. (Enlarged in reproduction.)

AIRCRAFT PARTS

Aircraft parts, routed and sheared at the location of aluminum alloy sheet fabrication, are now made available to the aircraft manufacturers. These parts are made to specifications as furnished by the aircraft manufacturer. The advantages of this are: less floor space will be required at the aircraft factory; a considerable saving in freight is effected, as it is estimated that approximately 30 per cent scrap is obtained; railroads are relieved of unnecessary burden; and more aluminum is available for immediate use as the time required for transporting scrap to and from the aircraft manufacturer is eliminated.

ROLLED ROD

Rod is considered to be a round with a diameter of $^3/_8$ in. or greater and is illustrated in Fig. 2; the smallest size pictured is $^3/_8$ in. diameter. Aluminum alloy rod is hot-rolled in rolls cut with variable contours to effect the change in shape and reduction necessary. Rolled rod can be finished in the annealed, as-fabricated, or heat-treated condition, the latter consisting of heat-treated, "as-rolled" or cold-finished. The fabricating operations consist of hot-rolling, drawing, annealing heat-treating, straightening and sawing. Wire is produced by drawing rolled rod and is considered any round less than $^3/_8$ in. in diameter. Common alloy wire is produced in annealed, intermediate and hard tempers. Strong alloy wire is produced in the annealed or heat-treated tempers. A relatively large amount of strong alloy wire is used to produce rivets for the joining of aircraft parts.

Rolled rod and wire are produced and inspected to conform to United States Government specifications. Rolled rod is inspected by checking dimensions, checking grade, checking temper, checking straightness and examining for surface defects. In the case of rolled rod for forging stock, a careful surface inspection is given, and rods containing such defects as blisters, slivers, seams, laps, pits, and pronounced handling marks are rejected. Rolled rod for screw machine stock is inspected less rigidly for surface defects, since such defects, unless severe, are generally eliminated by machining.

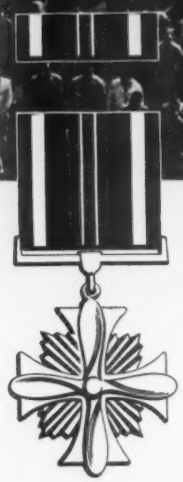
Various screw machine parts are made from 17ST rolled rod. Forgings are produced from fabricated or as-rolled rod and it has been estimated that 400 lbs. of forgings are used in the structure of the airplane described previously.[15]

TABLE 3

Results of Corrosion Tests Made on 0.040- to 0.064-In. Aluminum Alloy Sheet[14]

Material	Corrosive Conditions	Approximate Time of Exposure, Months	Approximate Percentage Loss of Initial Elongation
17ST, 17S-RT, 24S-RT	Accelerated salt spray (20 per cent NaCl solution)	2	50
		4	75
High purity aluminum coated 17ST, 24ST, 24S-RT	Accelerated salt spray (20 per cent NaCl solution)	4	0
		16	5
17ST, 17S-RT, 24S-RT	Exposure to weather at Washington, D. C.	16	2
		56	5
High purity aluminum coated 17ST, 24ST, 24S-RT	Exposure to weather at Washington, D. C.	16	0
		56	2
17ST, 17S-RT, 24S-RT	Exposure to weather at Hampton Roads, Va.	4	10
		20	20
High purity aluminum coated 17ST, 24ST, 24S-RT	Exposure to weather at Hampton Roads, Va.	20	0
		48	5

Ten thousand to One . . .



NEVER before in all history has so much depended on the *man behind the man* behind the gun. His battle lines are production lines; his weapons are the tools of his trade. Quotas be damned; whatever quantities are asked he must strive to exceed. His is the colossal task of changing "too little and too late" to "an abundance and on time."

There is an exaltation in mortal combat that drives men to heroic deeds. Medals of honor and a nation's gratitude justly reward their courage. For every hero so honored there are 10,000 unsung heroes in the battle of production. They are the men and women who toil without the spur of conflict in absolute devotion to freedom's cause. They are the *builders* of victory.

Final triumph will be won by the side that works hardest and produces the most. If all America matches the unrelenting efforts of the aircraft industry there can be no doubt which side that will be. Are your sleeves rolled up? Have you the right to consider yourself one of the ten thousand to one?

Donald W. Douglas

PRESIDENT, DOUGLAS AIRCRAFT CO.

U. S. Army Photo
Douglas Workers

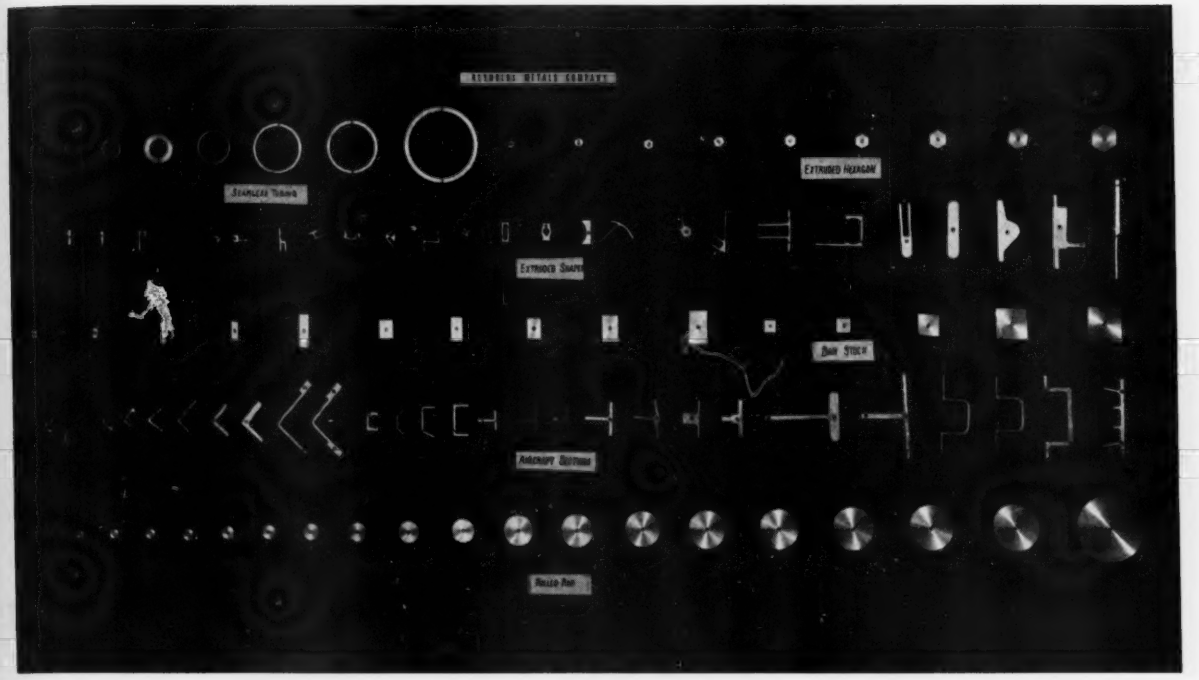


FIG. 2. Aluminum alloy extruded sections, extruded bar, rolled rod, and tubing.

EXTRUDED ROD, BAR AND SHAPES

Strong aluminum alloys are extruded in a variety of shapes for aircraft structures. Some of these shapes are illustrated in Fig. 2. Rod and bar are also extruded for machining into screws, nuts, bolts and various other fittings, as well as for subsequent forging.

Extrusion presses for aluminum alloys are hydraulically operated and vary in capacity from 500 to 5,000 tons. Aluminum alloy ingots ranging in size from 4 to 20 in. in diameter are extruded at temperatures ranging from 600° to 1,000°F., depending upon the alloy.

Extruded shapes are produced in the fabricated, annealed and heat-treated tempers. The fabricating operations are extrusion, annealing, heat-treating, stretching, sawing and straightening. Extruded rod and bar are produced in the same tempers as are extruded shapes but can be produced to closer dimensional tolerances by drawing; rod and bar of this type is termed "cold-finished."

Inspection of aluminum alloy extruded shapes consists of checking the grade and temper, the shape of the section, the dimensions, the straightness, the flatness, the contour and the surface quality. Light surface defects and discoloration are not considered detrimental. Extruded rod and bar receive an inspection similar to that given rolled rod.

Extruded sections offer an advantage to the designer over rolled or drawn shapes, in that the section can be designed to obtain the desired distribution of stresses. Jackman[15] has estimated that 500 lbs. of aluminum extrusions are used in the airplane described previously and are distributed as follows: wing, 150 lbs.; fuselage, 100 lbs.; tail surfaces, 50 lbs.; landing gear, 25 lbs.; controls and miscellaneous, 175 lbs.

However, this particular make and model had 1,500 lbs. of parts drawn from sheet, so that other types and models of airplanes of similar gross weight probably use considerably more extrusions.

TUBING

Common and strong aluminum alloy seamless tubing is produced in the annealed, intermediate, hard, and heat-treated tempers. Round tubing produced is pictured in Fig. 2. Square, streamline and special formed tubing are also fabricated.

Tubing is fabricated and inspected to existing Government specifications. The inspection of tubing involves checking grade and temper, determining dimensions, checking straightness, and examining for surface quality. The defects encountered on tubing are scratches, blisters, dinges, pits, holes, and breaks in the surface. The proper inspection of tubing requires considerable experience, since the tube has to be examined for surface quality of the inside, as well as the outside, surface.

17ST and 24ST tubing is used for structural parts of the airplane such as the airframe, control system, or power plant. Other aluminum alloy tubing, of which 52S is the main one, is used for aircraft fuel lines, oil lines and instrument lines.

PROCESSING

Strong aluminum alloy products are ordered in the annealed condition so that forming can be accomplished at the aircraft plant. The formed parts are then heat-treated by the aircraft manufacturer. The strong aluminum alloys should always be assembled in the aircraft structure in the heat-treated condition, since the corrosion resistance of annealed or partially worked strong aluminum alloys is inferior to the corrosion resistance in the heat-treated tempers. Precaution should be exercised in the heat-treatment of Pureclad 17S or 24S sheet, since the time of soaking at the heat-treating temperature determines the amount of diffusion of the alloying constituents into the high purity aluminum coating. This diffusion will reduce the corrosion resistance of the Pureclad sheet. Sachs and Van Horn have developed a formula for approximating the diffusion of copper through an aluminum coating during heat-treatment at 925°F.[16] The formula is that the depth of diffusion equals 0.0002 times the square root of the heat-treating time at 925°F.; substitution of heat-treating time in minutes gives the depth of penetration of the copper (or alloying constituents) in inches.

Aluminum alloy sheet can be drawn, formed, spun, or bent. The extent to

which the sheet can be worked, employing these operations, varies with the workability of the alloy and temper.

The strong alloys possess good machining characteristics and, consequently, can be turned, milled or routed, sawed, drilled and ground. Machining can be performed using the same tools that are used for machining steel, but better results are obtained using a modified tool, similar generally to the tools used in woodworking.[17] 17ST rod and bar, both extruded and rolled, possess excellent machinability.

Aluminum and its alloys can be welded by either of the two general types of welding procedures used today—namely, fusion welding, and pressure or resistance welding. Butt, lap, tee and fillet joints can be made in aluminum similar to those made in other metals. Welding is, as yet, not used to the same extent as mechanical joining in the aircraft industry, since heating of the heat-treated aluminum alloy tends to soften it, thereby weakening the structure.[18]

Other methods of joining aluminum and its alloys are riveting, soldering and brazing. The particular method to be used for a given application depends upon the nature of the pieces to be jointed, the cost of joining, the stress to be imposed and the conditions to which the joint is to be exposed.

General Considerations for Use in Aircraft

The density of strong aluminum alloys (approximately 0.1 lb. per cu.in.) and the strength comparable to mild steel make possible the building of structures having approximately one-third the weight of similar structures in heavy metal.

The relatively high corrosion resistance of aluminum alloys, particularly Pureclad, makes possible their use without surface protection in numerous cases. However, the strong alloys used in aircraft are protected dependent upon the structural design and the conditions to which the airplane is to be exposed. Corrosion of aluminum alloys depends upon contact with moisture or water, and salt water is a particularly active corrosive agent. Aluminum alloys are protected by painting or by the electrolytic deposition of an aluminum oxide coating. The latter is usually a chromic acid anodic treatment.[19] The methods of protection and the required characteristics of protective coatings are covered by United States Government Specifications.

Joints between dissimilar metals should be avoided wherever possible. In cases where dissimilar metals are joined, the faying surfaces should be painted and an insulating material that will not absorb or retain moisture should be used.

Other mechanical properties of strong aluminum alloys, such as endurance limit, modulus of elasticity, and shearing strength, have to be taken into consideration for particular applications.

References

[1] Edwards, Frary, and Jeffries, *The Aluminum Industry, Aluminum and Its Production*, pp. 126–131; McGraw-Hill Book Co., Inc., New York, 1930.

[2] Edwards, Frary, and Jeffries, *The Aluminum Industry, Aluminum and Its Production*, pp. 301–318; McGraw-Hill Book Co., Inc., New York, 1930.

[3] Goss, H. P., *Hot Working, Cold Working and Recrystallization Structure, The Working of Metals*, pp. 967–1036; American Society for Metals, 1937.

[4] Wood, W. A., and Smith, S. L., *A Stress-Strain Curve for the Atomic Lattice of Aluminum*, The Journal of the Institute of Metals, Vol. 67, Part 10, pp. 315–324, 1941.

[5] Sachs, G., and Van Horn, K. R., *Practical Metallurgy*, pp. 62–66; The American Society for Metals, 1940.

[6] Applicable United States Government Specifications.

[7] Mehl, R. C., *Metals Handbook*, pp. 207–213; The American Society for Metals, 1939.

[8] Zeerleder, A. V., *The Technology of Aluminum and Its Light Alloys*, p. 12; Nordemann Publishing Company, Amsterdam, 1936.

[9] Jeffries and Archer, *The Science of Metals*, pp. 403–406; McGraw-Hill Book Co., Inc., New York, 1924.

[10] Jeffries and Archer, *The Science of Metals*, p. 398; McGraw-Hill Book Co., Inc., New York, 1924.

[11] Phillips, S. H., *Aircraft Processes*, pp. 27–28; Crocker Co., 1941.

[12] Archer, R. S., *The Aluminum Industry, Aluminum Products and Production*, pp. 555–561; McGraw-Hill Book Co., Inc., New York, 1930.

[13] Fischel, J. R., *The Compressive Strength of Thin Aluminum Alloy Sheet in the Plastic Region*, Journal of the Aeronautical Sciences, Vol. 8, No. 10, p. 375. August, 1941.

[14] Mutcher, W., *Corrosion of Metals Used in Aircraft*, National Bureau of Standards Research Paper RP 1316, Vol. 25, U.S. Department of Commerce, 1940.

[15] Jackman, K. R., *Strengthening Aluminum for Aircraft Structures*, Metal Progress, Vol. 40, No. 1, pp. 35 and 36, 1940.

[16] Sachs and Van Horn, *Practical Metallurgy*, p. 454; American Society for Metals, 1940.

[17] Zeerleder, A. V., *The Technology of Aluminum and Its Light Alloys*, pp. 208–222, Nordemann Publishing Company, Amsterdam, 1936.

[18] Phillips, S. H., *Aircraft Processes*, pp. 73–80, H. S. Crocker Company, Inc., San Francisco, 1941.

[19] Phillips, S. H., *Aircraft Processes*, pp. 96–105, 121–130, H. S. Crocker Company, Inc., San Francisco, 1941.

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Recent Developments in Airships

K. ARNSTEIN*

Goodyear Aircraft Corporation

THE PRESENT EMERGENCY has given the airship program the needed impetus to resume activities after its somewhat abrupt cessation in the middle thirties. Although the actual construction of airships may have been somewhat dormant during this time, with the exception of an occasional nonrigid airship, research and development were in continual progress, particularly at the Goodyear Aircraft Corporation and the Daniel Guggenheim Airship Institute at Akron.

At the present time, the construction of nonrigid or "blimp" type airships has approached large-scale production in order to meet the demands of the recent Navy program of maintaining an aerial coastal patrol. One such airship of the K type is shown in Fig. 1.

A primary function of these airships is the spotting of submarines and mines. They are able to do this with exceptional efficiency, since it is possible for blimps to slow down and even hover over an object. Then, unlike airplanes or surface vessels, they are able to spot periscopes or other small objects whose detection would be extremely difficult from a fast-moving craft.

The present series of airships being constructed for the Navy are equipped for long-range patrol duty, even to the extent of incorporating a galley and bunks for the crew. This, coupled with the recent development of the sea anchor that permits the blimp to anchor anywhere during its patrol to pick up fuel and supplies, affords ample opportunity for patrol flights of several days' duration.

These airships will operate from a string of bases stretching from Massachusetts to Florida and Puget Sound to Southern California. Thus, they afford much needed protection to shipping in our coastal lanes. Records show that in World War I no convoy escorted by blimps was ever successfully attacked by submarines.

Although the larger rigid airships are as yet not in the picture, considerable research and development work is now in progress in that direction, both from aerodynamic and structural consideration.

Projecting this groundwork into the future, one would see an aerial aircraft carrier of 10,000,000 cu.ft. capacity. With a range of some 10,000 miles, this mother airship would carry ten attack bombers in its hold and would be capable of launching them simultaneously.

The tactical utility of such an arrangement has been subjected to considerable debate in the past. The continuance of such a discussion is not within the scope or the purpose of this paper. However, the function of the airplane-carrying airship, like that of the surface carrier is not necessarily to fight but to deliver fighting airplanes to a point within their own range of the objective. That it can do this with greater speed and less probability of detection becomes quite apparent when one considers the fact that not only is the speed of the airship more than twice that of the surface carrier but that it is capable of hiding in the clouds if it becomes necessary. Consequently, the vulnerability of such airplane-carrying airships becomes appreciably less than that of surface carriers, particularly when considered in the light of the personnel and equipment involved.

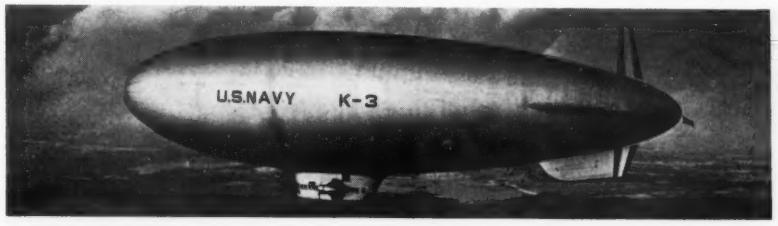

FIG. 1. Nonrigid airship in flight.

AERODYNAMIC FORCES IN AIRSHIPS' BODIES

It has long been recognized that one of the severest stress conditions occurs upon the ship encountering a gust or a sudden cross-wind. Therefore, recent problems along the lines of the aerodynamic forces on airship bodies and control surfaces in both controlled and free flight have been investigated, particularly with the object of determining the effect of these gust conditions and maneuvers.

Under the auspices of the Durand Special Committee on Airships and the Navy Department, extensive tests have recently been conducted on a $1/150$ scale model of the Akron and Macon airships in the water channel at the Guggenheim Airship Institute to provide additional information on the forces and bending moment in the hulls and control surfaces. These experiments serve as an excellent check on previous full-scale and wind-tunnel model tests.

For the first time, airship models have been tested in free flight and self-propelled under carefully controlled conditions that have brought to light many factors confusing previous wind-tunnel tests. All the details of these investigations are too numerous to present. However, the description of the model testing arrangement and some of the pertinent tests are given because of their bearing on the general phase of this type of investigation.

The water tank proper consisted of a straight water channel 8 ft. wide, 23 ft. long and $5\frac{1}{2}$ ft. deep. Through 8 ft. of this straight section a controlled crossflow could be introduced by means of a C-channel similar to an open-jet wind tunnel. Thus, the model, if pulled parallel to the axis of the straight section, could be hit by the crossflow from the C-channel simulating conditions of an airship in flight hit by a gust from the side. The flow of the crosscurrent could be controlled so that anything from a sharp-edged gust to a uniformly varying gust would be produced.

For the purpose of propelling and/or controlling the model in one plane, a test carriage was developed to run over the straight section of the water channel. It was so designed that when the model was immersed to its predetermined depth in the water channel and held by the small rod connected to the carriage the model could be propelled and permitted to turn freely in the horizontal plane about the axis of the rod which would transversely follow the flight of the model without restraint. Or, if desired, the model could be restrained against rotation or translation

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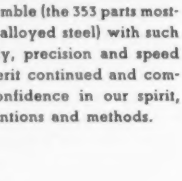

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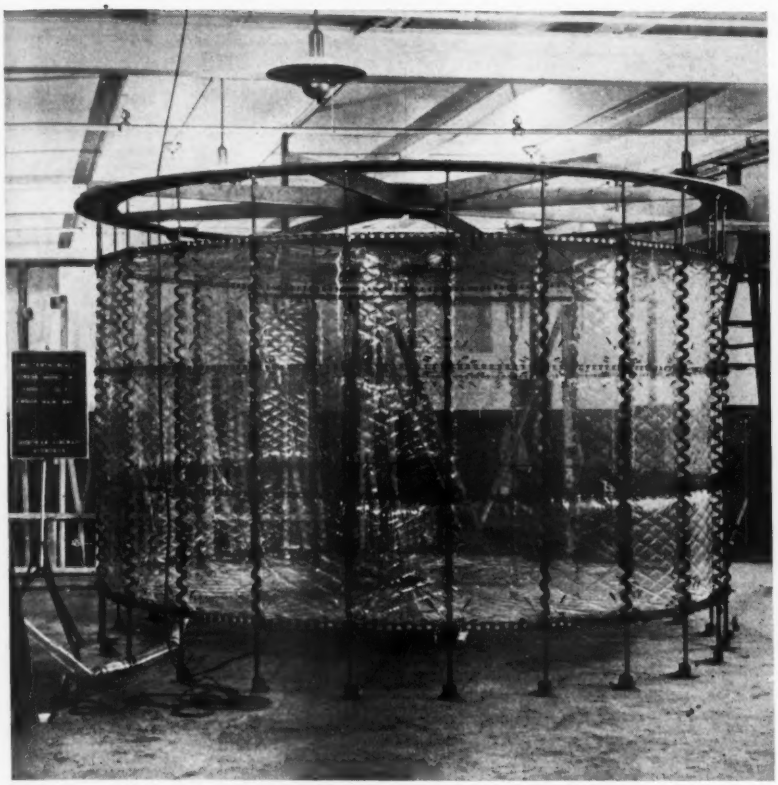


FIG. 2. Stress model of rigid airship bay.

until the desired moment for release has arrived.

The movement of this cross-carriage and the rotation of the model about its center of buoyancy could be recorded on a drum incorporated on the main carriage. Records of the attitude of the model and the motion of flight could then be reconstructed, showing the effect of the gust on the model.

The forward propulsion of the model was accomplished by releasing weights that pulled the main carriage and, hence, the model, at a constant thrust through the region of the gust, thus simulating the effect of an airship driven by propellers.

From this test arrangement it can easily be seen that by installing proper equipment on the main carriage the position of the model and yaw desired at the moment its nose meets the gust can be accurately controlled. Any desired movement can be forced on the model during its passage through the gust. A great deal of flexibility was built into the test equipment for the determination of the forces and moments on the airship model in this manner.

The design of the model included provisions for measuring bending moments at several different cross sections along the hull and for measuring forces and moments on the control surface and also included means for controlling the action of the movable surfaces. The latter feature was especially necessary in simulating controlled maneuvering conditions and for procuring accurate information in the free flight tests.

In order to obviate the restraint impressed upon the model by the forward driving rod as it went through the cross-flow or gust, a free flight condition was obtained by permitting the airship to drive itself.

For the free flight tests, which were far more illuminating, the model incorporated conventionally located propellers driven by small electric motor and battery combinations self-contained in the model hull. Provisions for setting the movable control surfaces in flight and equipment for measuring the bending moment on the hull were also incorporated in the model, thus duplicating an airship in free flight as closely as possible. The motion of the model was recorded photographically and a separate means was provided to supply initial acceleration to the model.

A large number of basic investigations were thus conducted in an attempt to ascertain the effect of maneuvering and gust conditions on the hull and control surfaces. Of particular importance was the maximum bending moment curve which enveloped the curves of the bending moments at various stations along the hull. As the model entered the gust, maximum bending moments in the forward part were found to be approximately proportioned to the product of the model velocity times the gust velocity within normal gust and flying speed ranges. However, this relationship broke down as the tail entered the gust, since at this point the theoretic lift starts to deviate from the actual lift.

Observations were made on various-shaped fins in conjunction with these tests in order to ascertain the effect on the influence of aspect ratio and angle of attack under various simulated gust conditions. These investigations showed that the higher aspect ratio fins produce higher effective angles but less total loads and, at the same time, that the maximum effective angle of attack decreases the faster and farther the rudder is moved to an angle against the gust. Likewise, the maximum effective angle of attack on the fins decreases with decreasing ratio of gust velocity to model velocity.

Tests run over a wide range of Reynolds numbers led to the conclusion that stability investigations in the water have about the same justification as wind-tunnel tests under the limitations imposed by the test setup.

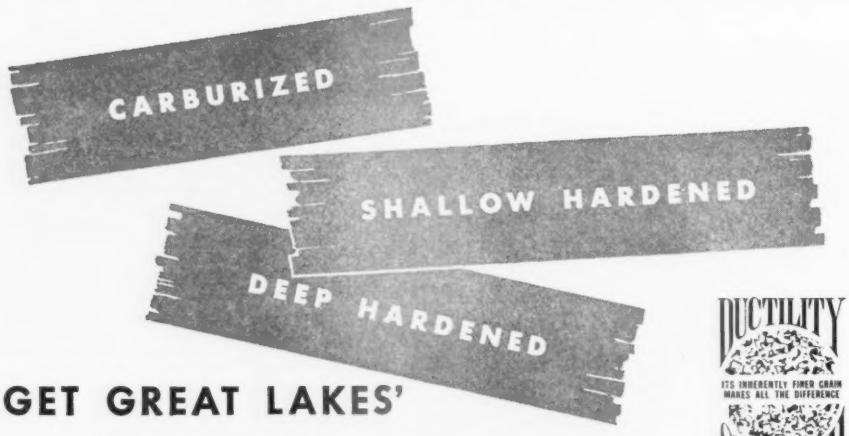
STRESSES IN RIGID AIRSHIP HULLS

While these aerodynamic investigations were in progress, the structural phase was also being considered. Stress calculations of airships present such a highly specialized and complex problem of applied mechanics that it is usually recognized to have reached a degree of refinement not attained in other branches of engineering. These problems were presented at the Fifth International Congress for Applied Mechanics by K. Arnstein and E. L. Shaw of Goodyear Aircraft Corporation and may be found in the *Transactions* in which they show that the most generalized stress problems have been cleared up. However, there still remained the gap between the generalized type and detail construction.

The framework of a rigid airship presents a space structure with a high degree of redundancy. Theoretically, any redundant space framework can be analyzed completely for any loading condition by ordinary strain energy methods. However, a structure such as an airship demands the solution of so many simultaneous equations that the actual labor involved makes this type of analysis impractical. Therefore, in order to arrive at a reasonable solution, the airship engineer turned to a method of calculation involving simplifying assumptions and relied on full-scale or model tests to confirm the validity of these assumptions.

In order to verify these assumptions, the construction of structures models had been undertaken in the past. These

FOR PARTS TO BE



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Molybdenum	Nil	.10/.20
Zirconium	.10/.20	.10/.20

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earlier models had made several simplifications concerning shear wiring, outer covering, and gas cells. However, with the help of the Navy Department, a new model has been recently constructed in order to investigate more thoroughly these important stress features.

Fig. 2 is a scale model of the main bay of a 3,000,000 cu.ft. ship. The physical dimensions of the model are about 10 ft. in diameter by 5 ft. long for this one particular bay. This is a structures model, and not a scale model, and as such the girders are made to simulate the stiffness properties and not the actual physical shape of the prototype. This becomes quite apparent upon closer inspection of Fig. 2 which shows the girders to have a fish-worm shape instead of the usual box structure. By the proper geometric juggling of the shape of these girders, it was possible to simulate exactly four of the six stiffnesses and to approximate the other two. The simulated stiffnesses were: (1) axial, (2) and (3) bending in two directions, and (4) torsional. The (5) vertical and (6) lateral shears were approximated. The model was so constructed that actual stresses were simulated, the scale being such that the force was proportional to the length squared. Convenient means for accurately measuring the stresses in these model girders were incorporated.

By making the scale stiffness of the outer cover and the gas cell nearly to scale, it was possible to test for the effect of any one or combination of the following loadings: pure shear, gas pressure in cell, and pressure gradient and gravity.

Stresses in Nonrigid Airship Envelopes

The stresses peculiar to a nonrigid airship or blimp are obviously quite different from those of the rigid airship hull. Here, all forces must be resisted by fabric in shear and tension, since it is quite apparent that a piece of cloth cannot assume loads in compression or bending and must derive its rigidity against compression loads by internal pressure alone.

The blimp hull or fabric envelope may be treated as a simple beam of varying cross section and, as such, it is a simple matter to determine the maximum shears and moments that must be resisted. However, the local distribution of stress is definitely contingent upon the method of load distribution. Present practice in nonrigid airships dictates the use of internal suspension—that is, long curtains are sewed on the inside of the envelope from which are suspended cables attached to the control car. By means of this arrangement, an attempt is made to distribute the loading over the entire envelope in such a way that a minimum of sagging results in the hull due to the weight of the control car. This can be done by properly proportioning the load distribution and the shape and location of the suspension curtains. As the size of nonrigid envelopes were increased, this sagging problem became more acute.

In order to study the effect of suspension and related problems, a "water model" of the blimp was constructed. This was a fabric hull about 8 ft. long by 2 ft. in diameter, geometrically similar to the prototype, including approximations for seams, patches, curtains, etc. By filling the envelope with water and suspending the entire airship by the control car, actual stress conditions created by both buoyant and dynamic lift were simulated. The weight of the control surfaces, nose stiffeners, and other extraneous loads were compensated for by counterweighing. A novel method of counteracting the weight of the envelope fabric was utilized by displacing the inner surface of the envelope by means of hermetically sealed rubber sponges. Then, by fastening strain gauges throughout the entire surface of the envelope, it was possible to determine the strain at any point in the hull. This information is particularly useful in predicting fabric wrinkling, which will obviously occur when the stress at any point in the hull is reduced to zero. This, coupled with the contour data taken of the shape of the hull for the various loadings, afforded sufficient background for a more intelligent approach to the sagging problem.

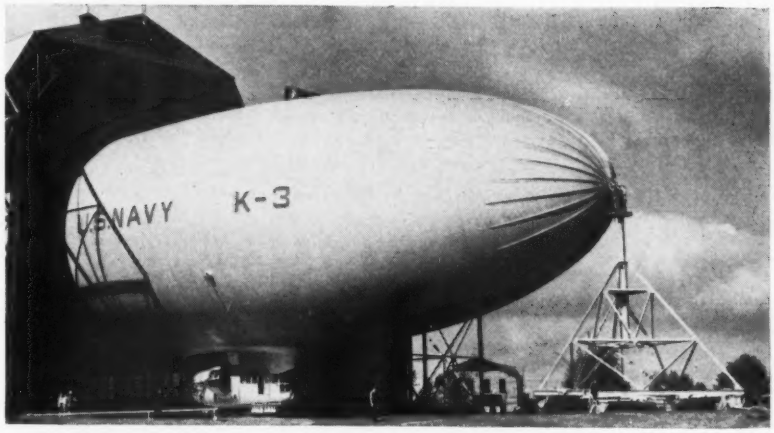

Fig. 3. The K-3, a nonrigid airship. This blimp is 246 ft. long and 76.5 ft. high and is powered by two Wright Whirlwind 450-hp. engines.

The information obtained from these investigations were applied to the current series of K-type airships now being built for the Navy with very satisfactory results (Fig. 3).

Of renewed interest in the lighter-than-air field is the barrage balloon, an improved development of the current war, one type of which is shown in Fig. 4. Considerable flight work has been done in improving their stability and flight characteristics. Much of this work has been made possible following the development of a radio-controlled photographic flight analyzer. By means of this, it has been possible to obtain a complete photographic record of the atmospheric and flight conditions of the balloon at any desired altitude and time.

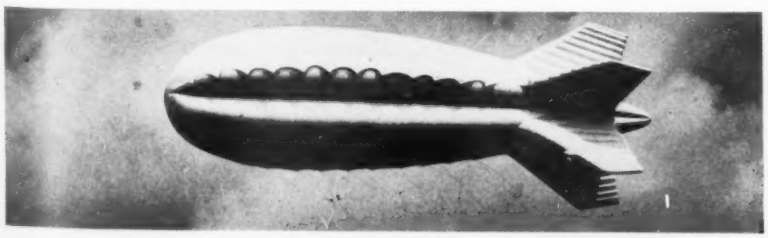

Fig. 4. Barrage balloon.

Bibliography

Shaw, E. L., *Use and Operation of Airship*, Aeronautics, Vol. VI, No. 31, pp. 1921–1938.

Arnstein, Karl, "The Engineering Treatment of Ring or Wheel Problems," Theodore von Kármán Anniversary Volume, *Contributions to Applied Mechanics and Related Subjects*, pp. 195–211; California Institute of Technology, Pasadena, Calif., 1941.

Donnell, L. H., Gibbons, H. B., and Shaw, E. L., *Analysis of Spoked Rings*, Journal of Applied Mechanics, A.S.M.E., Vol. 8, No. 2, pp. A-67–A-73, June, 1941.

Allen, Hugh, *The Story of the Airship*, Goodyear Tire and Rubber Company.

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While the Axis rehearsed in China and Europe for this war, America's aircraft industry rehearsed too... expanded... and completed United States approved warplane orders for Britain and others in the front line of our defense.

In a dead serious dress rehearsal for today, we designed greater, tough-muscled warplanes, and geared for greater mass production. That's why American planes are this war's hard-boiled babies. That's why we are building more of them today, and will build yet more tomorrow. That's why air mastery inevitably will be with the United Nations.

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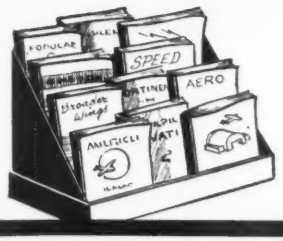

Periodicals

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Accessories

A War Gas That Saves Lives. The properties of carbon dioxide are described together with the various ways in which it is used for the prevention and control of fires in aircraft and as a life-preserver filling agent in case of accidental descent upon water. The processes of making the substance, as well as its applications for fire extinguishing in industrial plants, are reviewed and illustrated. *Popular Science*, June, 1942, pages 53–57, 11 illus.

Aerodynamics

Predicting Parasite Drag. Willoughby Nason Hammond. This article presents a method whereby the parasite drag coefficient of a design can be calculated when the total wetted area is known. *Aero Digest*, May, 1942, pages 224–226, 260, 3 illus.

Lift, Load and Landing. Functions of the Fowler flap and its construction and operations are treated in this brief article. Some of the structural problems are outlined and comparisons are made with other high-lift devices including the Gouge flap, the Handley Page flap and the Youngman flap. The slot effect is explained. *Flight*, April 9, 1942, page 353, 2 illus.

Charting Aircraft Stability. Courtland D. Perkins. The second in a series on the graphic solution of dynamic stability, this installment outlines the application of the stability chart to dynamic longitudinal stability. *Aviation*, May, 1942, pages 123–125, 256, 259, 2 illus.

Air Power

Air Power in the Pacific. John A. Ward. Successes achieved to date by the Japanese in the Pacific area are compared with the victories of Hitler's forces on the Continent, showing that the war of surprise, rapid movement and overwhelming air power with which the Germans stunned the world and conquered a large part of Europe have been paralleled by the tactics of the Japanese. Although Hitler's major operations have been on land while the Japanese accomplished their work on the sea, the similarity of the methods is held to be significant. It is stated that the Japanese massed more aircraft on ships than any nation had ever before attempted, and they crowded more aircraft carriers into the Pacific theater of operations than Great Britain and the United States had in all the rest of the seven seas. By maneuvering under canopies of airplanes the Japanese are credited with having been able to overrun important parts of China, Indo-China, the Philippines, the Dutch Indies, Malaya and Burma, while the United Nations had inadequate air power to resist them.

The development of the Nazi military and air power is reviewed and responsibility is placed on the Allied Governments for failure to take action in time to prevent its growth or to oppose its progress. The article concludes with an outline of the steps that should be taken by the United Nations to bring adequate air power to bear to assure the final victory. *Aero Digest*, May, 1942, pages 54, 56, 58, 3 illus.

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Air Transport

Pan Am Fights the Axis. Richard Hubler. A brief history of how Pan American Airways has expanded in South America to the exclusion of Axis-dominated airlines. Indicating how Pan American was aided by the United States and Latin-American governments who wished to eliminate the militant-purposed Axis lines, this gives credence to the theory that civil and military aviation are closely allied. *Flying and Popular Aviation*, June, 1942, pages 38, 39, 74, 78, 80, 4 illus.

The Care and Feeding of a Giant. Edward Churchill. This record of the cost of maintaining and operating T.W.A.'s No. 370 proves the hypothesis that "it isn't the original cost, it's the upkeep." Figures are given on all operational and nonoperational costs from the salaries of the flying crews down to the yearly charge-off for stolen salt cellars. The efficiency of maintenance, which necessitates the greater part of this upkeep burden, however, is credited for the long life of the airliner. *Flying and Popular Aviation*, June, 1942, pages 44–46, 114, 3 illus.

Transport Fleet Shows Little Growth. An analysis of the domestic air industry's equipment situation, indicating that, despite the increase in traffic, seating capacity has risen only 6 per cent. The article includes a chart showing the number of aircraft and engines acquired and sold by each airline in 1942. *American Aviation*, May 1, 1942, page 38.

Sources of Feeder Airline Business, Part I: Passenger Traffic. John H. Frederick and William J. Hudson. An analysis of the present and potential volumes of passenger air traffic is presented in considerable detail. It is confined to one of the three basic questions bearing upon the general problem of feeder airlines, being concerned with the adequacy of present commercial air transportation services and disregarding the other two aspects—whether the air transport industry or the Government can support a nationwide feeder airline program and the effect of such a program on present channels of transportation and distribution.

Holding that the problem should not be attacked on a basis of civic pride or civic benefit or under the guise of national defense but only on the basis of sound economics, the writers make a survey of the distribution of population and purchasing power with relation to present airline services, allowing for the influence of large cities and other factors. Present sources of airline passenger traffic are examined, leading to the general conclusion that while the most important commercial and industrial centers appear to have been adequately tied together by commercial air transportation scant attention has been paid to opening this new medium for hundreds of smaller communities. It is found that less than 30 per cent of the population has direct access to scheduled airline facilities and only 42 per cent of the nation's purchasing power has been tapped, leaving 58 per cent of consumer purchasing power approximately 70 per cent unexploited in the field of air transportation. Six tabulations are presented showing the percentage distribution of population, purchasing power and airline services in the nine major census districts. *The Journal of Air Law and Commerce*, April, 1942, pages 99–115, 1 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

The Capacity of Air-Carrier Terminals. A. F. Bonnalie. Some of the considerations involved in the location and arrangement of air-carrier terminals are examined in the light of the relative advantages of multiple airports and the union-station type of terminal. Factors having a bearing on the matter include the accessibility of the city to available airport locations, the highway layout and the cyclic trends of travel habits. Peak periods for arrivals and departures vary according to the location and nature of the airport, and each field will have a different set of conditions depending upon whether the preponderance of traffic is in long or short journeys and whether the airport is a terminal or intermediate station.

Charts and statistics are presented showing traffic movements at various airports. Estimates of the future growth of air transportation are set forth on the basis of six major points covering passenger, mail and cargo traffic, and other minor factors are taken into account. Terminal facilities and the movements of airplanes are studied, concluding with consideration of radio equipment, flight aids and runways. *Mechanical Engineering*, May, 1942, pages 377–383, 6 illus.

Air Transport in War-Time. Sam Meiklejohn. An exposition of the special restrictions and conditions under which transport airplanes are permitted to operate in Europe. A compendium of the services remaining in operation is included in this report. *Aeronautics*, April, 1942, page 41.

Ships Over the Sea. Grover Loening. For the transportation of military supplies and troops during the war and of commercial goods after the war, the use of large aircraft is compared with the service now performed by surface ships. Referring to the demonstration of the efficiency of mass air transportation by the Germans in Poland, Holland, Norway, Crete and elsewhere, the writer holds that aerial freight movement has been neglected in the United States, although passenger traffic was developed on a scale not equalled in any other country. Whereas other transportation systems derive some 80 per cent of their revenue from freight, air cargo in the United States has accounted for only 2 or 3 per cent of gross earnings.

Consideration is given to the range of present aircraft in connection with the problems of transportation to the war areas and the loads that can be carried to current and prospective scenes of activity. The maximum practicable range is placed at about 4,000 miles and the cargo capacity of the latest types of large aircraft is analyzed and placed at about 20 tons. On this basis, comparison is made of the ability of a number of such aircraft to deliver a tonnage of goods equivalent to the capacity of the average surface freight ship traveling in convoy and of the newest and fastest surface ships without convoy. It is estimated that 15 of the present 80-ton aircraft could carry the same tonnage of freight from the United States to the Red Sea in a year as one steamship of 11,000 tons capacity, and 21 such airplanes could equal the work of one of the newest freight ships, although the capital investment would be three times that required for the surface vessel. However, for war purposes the greater assurance of delivery and the freeing of naval escort vessels are held to offset the increased cost.

The writer then visualizes the transport aircraft of the future and its ability to reach the most distant parts of the world with useful loads of military or civilian goods and concludes that the carriage of cargoes by aircraft has such outstanding advan-

tages that it should be adopted at once. *Foreign Affairs*, April, 1942, pages 489–502.

Long Way Home. Byron Fish. What happened to the four Pan American Clippers which were enroute when war broke out on December 7 forms the contents of this article. Although, according to prearranged plan, their destinations and courses were changed—one even circling the globe and completing the first around-the-world flight of a commercial transport of this type—the Anzac Clipper (Boeing B-143), the Pacific Clipper (Boeing), the Phillipine Clipper (Martin 130) and the Hongkong Clipper (Sikorsky S-42) all managed to make port safely. Actual route of the transglobular flight is still a secret but conjecture is made as to its probable path. *Canadian Air Cadet*, April, 1942, pages 8, 22, 3 illus.

Airplane Descriptions

Manta Fighter Has Contra-Rotating Props. Details are presented in nontechnical language on the new Manta fighter, which features counterrotating propellers and midship location of the Allison engine. The operation of the propellers is explained and the performance and armament of the airplane are mentioned. Comments are made on the wing structure, the framework of welded steel tubing covered by a molded plastic skin, and the means provided for converting the aircraft from a fighter to a dive bomber. Illustrations include photographs of a mock-up of the airplane, sketches of the engine and propeller layout and a three-view drawing. *Popular Science*, June, 1942, pages 62–64, 5 illus.

The 1942 Piper Cruiser. Preceded by a brief account of the promotional work that is being done by W. T. Piper and his assistants, this story of the new Piper Cruiser not only describes its construction and performance but also suggests that it has a contribution to make to the war effort. Some of the changes embodied in the new model include a completely enclosed engine and a semicantilever landing gear, an increase of 25 hp. over the 1941 model, shifting of the gasoline tanks to allow more head to the fuel flow, moving back of the front seat for greater visibility, softening of control action, and restriction of rudder travel. The suggested uses of the Cruiser for military purposes are for carrying 500-lb. cargo loads over 400-mile jumps, as troop carriers, ambulances, and patrols. *Air Facts*, May, 1942, pages 37–43, 2 illus.

Official Data on Enemy Aircraft Revealed. The first official description and authoritative performance figures on German, Japanese and Italian aircraft were released recently, covering 50 types on which information has been definitely determined. General figures on some of the Japanese types are reproduced in this article. They include several types of Mitsubishi bombers and fighters, some of the Kawasaki and Nakajima types as well as the Aichi and Awanishi naval craft. *American Aviation*, May 1, 1942, pages 10–17, 5 illus.

New Aeroplanes of the Red Air Fleet. From information gleaned on their action against the Luftwaffe, an analysis is given of the newer types of Russian aircraft. The illation is made that Russia has concentrated on close support types for cooperation with the Army and has rather neglected the heavy bomber.

In the fighter class the I-26 and the MIG-3, low-wing, single-seater, single-motor monoplanes with inward retracting undercarriages are described. The Stormovik, or IL-2 (BSch), is mentioned among the ground attack and dive bombers, as is the SU-2 (BB-1) and the SB-RK. The YAK-4 (BB-22) and the PE-2 are depicted as the two new types of light reconnaissance bombers; the GST and the KOR-1, as the seaplanes. Drawings supplement the brief descriptions and a list is given of what now appears to be the principal operational types in the Red Air Fleet. *The Aeroplane*, April 3, 1942, pages 382, 383, 12 illus.

The Westland Whirlwind I. Stating that the Westland Whirlwind is the only two-motor single-seater fighter in service with the R.A.F. at present, this description briefly presents its armament specifications and special features. *The Aeroplane*, April 3, 1942, page 380, 5 illus.

American Civil Aircraft. A descriptive directory of currently built American civil aircraft and those whose construction has recently been suspended because the factories building them have been devoted to war use. The directory covers over 80 types, providing the dimensions, weight, power, performance and equipment, as well as pictures and three-view drawings for many of the types. *Western Flying*, April, 1942, pages 52–102, 88 illus.

The Short Stirling—England's Largest Bomber. The origin of the largest bomber so far produced in Great Britain is traced back to a 1936 design. Specifications are given of the complete airplane and of its components, and the methods of construction are outlined. Photographs show some of the operations in building and assembling the aircraft, and drawings are reproduced from *The Aeroplane* revealing details of the interior layout and of the mechanisms actuating the flaps and the undercarriage. *Automotive and Aviation Industries*, April 15, 1942, pages 20–27, 19 illus.

Specifications and Performance Data of Certificated American Airplanes in Use but Out of Production. A tabulation of the power plants, dimensions, weight and performance of 105 types of American aircraft still in use but no longer in production. Only those types of which 15 or more were produced are included in the list. Similar statistics are provided for 95 nonmilitary models currently being built. This list is subdivided into groups according to their passenger capacity. *Western Flying*, April, 1942, pages 48–51.

Ajax Defied the Lightning but He Didn't Lock a Thunderbolt. Some performance statistics indicate why Republic's Thunderbolt has elicited enthusiasm from the British. Powered by a 2,000-hp. engine and with an effective turbo-supercharger, the Thunderbolt has maximum fighting characteristics. While, as is also the case with specifications, few details of the Thunderbolt's armament are disclosed, it is stated that when the full armament of this airplane is functioning it is delivering kinetic energy to the bullets at the rate of 118,200,000 ft.lbs. per min.! *Commercial Aviation*, April, 1942, pages 48, 50, 2 illus.

American Military Aircraft. Photographs, three-view drawings and, where military censorship permits, dimensions, specifications, equipment and power plant data on the types of airplanes currently used by the Army and Navy. *Western Flying*, April, 1942, pages 106–150, 115 illus.

Swift GC-1 Light Airplane. Description of the Swift GC-1, a low-wing, two-place, side-by-side monoplane, powered by an 80-hp. A-80 Continental engine. Incorporating such features as a controllable-pitch propeller, flaps and a retractable landing gear, the Swift has a top speed of 135 m.p.h. and a cruising range of 530 miles. *Aero Digest*, May, 1942, page 230, 2 illus.

Westland "Whirlwind" Fighter. Description and performance comparison of the Westland Whirlwind twin-engined, low-wing, single-seater fighter. Powered by two 885-hp. Rolls-Royce Peregrine engines and armed with four 20-mm. Hispano-type

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shell-firing cannon, the Whirlwind is reported to have a top speed of over 353 m.p.h. *Aero Digest*, May, 1942, page 237, 3 illus.

The S. E. 4. C. M. Poulsen. Another British airplane designed and built before the first World War of 1914–1918 is described briefly, with particular reference to the features that are said to have been ahead of their time. The characteristics of this early tractor biplane, powered by a double-row, 14-cylinder Gnome rotary engine of 140 hp., driving a four-bladed airscrew are compared with present designs, especially the wing structure. *Flight*, April 9, 1942, page 344a, 1 illus.

Junkers Ju 88-A6 Bomber. Description of the new version of the Ju 88 twin-engined combination horizontal and dive bomber, indicating the changes recently incorporated to effect increased performance. This includes changes in the power plant and supercharger, bomb and armament locations, tank positions, crew posts and other modifications. The performance figures from tests run by the British Air Ministry of a captured Ju 88 are given. *Aero Digest*, May, 1942, pages 255, 265, 266, 2 illus.

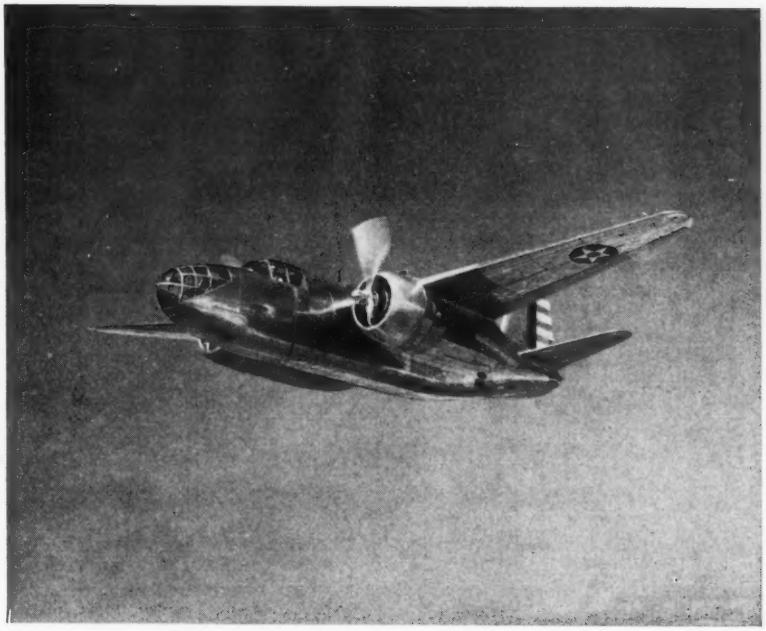
British Aircraft. Photographs and silhouettes of currently used military aircraft manufactured in England. These include fighters, bombers, patrol craft and trainers. *Aviation*, May, 1942, pages 77–79.

Transition Trainers. Descriptions of the Beech AT-10, the Cessna Bobcat and Crane and the Curtiss AT-9 which are used by the Army as transitional trainers to bridge the gap between single- and multi-engined equipment. *Aviation*, May, 1942, pages 201, 255, 256, 4 illus.

Westland Whirlwind. Description of the Westland Whirlwind, a twin-engined low-wing fighter, powered by two 860-hp. Rolls-Royce Peregrine engines. It is armed with four 20-mm. Hispano-type shell-firing cannon and features a full-cantilever cruciform tail. *Aviation*, May, 1942, pages 203, 256, 3 illus.

De Japansche Luchtstrijdkrachten, Part I, Part II and Part III (The Japanese Air Force, Part I, Part II Part III). A compilation is presented of Japanese pursuit and fighter airplanes giving photographs, three-view diagrams, construction details, specifications and armament of the Navy 95, 96, 97 and the Army 97, Messerschmitt Me 109 and Messerschmitt Me 110 aircraft. No photograph of the Navy Zero is available.

Part II covers Japanese bombers in a similar manner, giving information on the Navy Mitsubishi 96 and the Army Mitsubishi 97, Fiat BR-20M, Mitsubishi 98, Kawasaki Kawa 95 and the Junkers Ju 88.



The Douglas A-20A attack bomber.

Part III is devoted to dive bombers and torpedo airplanes, giving information on the Navy 94 dive bomber, the Mitsubishi 96 dive bomber, the Nakajima 96 torpedo airplane, the Mitsubishi 97 torpedo airplane and light bomber, and the Army and Navy Junkers Ju 87 dive bomber. *Vliegwereld*, January 28, 1942, pages 801–803, 13 illus.; February 5, 1942, pages 6, 7, 11 illus.; February 12, 1942, pages 18, 19, 10 illus.

The Spitfire in Production. Part I. Wilfred E. Goff. The first in a series of two articles is concerned with the construction and production processes of the Mark V Spitfire. Of proved high performance, this low-wing cantilever monoplane fighter embodies all-metal, stressed-skin construction and is powered by a Merlin XLV engine. Given are particulars about its wing structure, boom subassemblies, leading-edge skin sections, processes of stretching, drilling and edge trimming. Intensive study is made of the gun ports, leading-edge assembly, pintle assembly, joining leading-edge sections, main attachment holes, and checking undercarriage fittings. Other topics discussed are: cannon bay structure, main assembly fixture, interspar and trailing structure, installation of services, undercarriage actuation, final operations, ailerons and skin plating. *Aircraft Production*, April, 1942, pages 284–294, 30 illus.

Focke-Wulf Fw 190. Description of the new German single-seater fighter, the Fw 190, a low-wing monoplane powered by a 1,600-hp. 14-cylinder, two-row B.M.W. engine. The new fighter has a top speed of about 370 m.p.h., a service ceiling of about 38,000 ft. and is armed with six heavy-caliber machine guns. *Flight*, March 26, 1942, page 285; *The Aeroplane*, March 27, 1942, page 351, 1 illus.; and *The Aeroplane Spotter*, March 26, 1942, page 75, 1 illus.

Heinkel He 177. An artist's conception and a speculative description of the new Heinkel He 177 heavy bomber. A low-wing monoplane of 103-ft. 4-in. wingspan, it is supposed that each of the two nacelles contains two liquid-cooled engines driving a common contrarotating propeller. Despite the weight and size of the machine, it is equipped with diving brakes. The He 177's top speed is estimated at 285 m.p.h. *Flight*, March 26, 1942, page 285, 2 illus.; *The Aeroplane Spotter*, March 26, 1942, page 74, 1 illus.

An Old-Time Racer. G. Geoffrey Smith. Description of the Bristol 72, a single-seater racing airplane, powered by a 450-hp. Bristol radial engine. Built in 1922, this braced low-wing monoplane incorporated such features as full-monocoque fuselage construction, retractable landing gear, wing-root fillets and a fully cowled engine. Its estimated top speed was 220 m.p.h. *Flight*, March 26, 1942, pages 286, 287, 4 illus.

The Handley Page "Halifax" Heavy Bomber. The first of a series on the Handley Page Halifax four-engined midwing bombers, this installment reviews the history of the

company and offers a general description of the structure, dimensions, performance and armament of the craft, as well as the test pilot's reaction to its flying characteristics. *The Engineer*, April 24, 1942, pages 344–346, 4 illus.

The Mitsubishi "OO" Navy Fighter. A résumé of the British Air Ministry's official description of the specifications, armament and performance of the Mitsubishi "OO" carrier-borne, single-seater fighter. The airplane is an all-metal, stressed-skin, low-wing monoplane, powered by a 900-hp. Nakajima engine. *The Engineer*, April 24, 1942, page 347.

Focke-Wulf Fw 189 Short-Range Reconnaissance Aeroplane. H. Conradis. Description of the twin-engined Fw 189 observation type. The pilot, observer and wireless operator are housed in an independent nacelle, while the engine nacelles are developed into tail booms to support the *empennage*. Exhaust directing devices are applied as deicers. *Aeronautics*, April, 1942, page 38.

Turret Fighter. J. Russell. Description of the two-place, turret-equipped Boulton Paul Defiant, giving particular attention to the theory, construction and operation of the four-gun turret with which it is armed. *Aeronautics*, April, 1942, page 48, 49, 2 illus.

The Lockheed Constellation. T. W. Ayers. An account of the development and the constructional and operational features of the airliner which promises to make the coast-to-coast run in $8^1/_2$ hours. From a commercial transport standpoint its listed advantages are: capacity of 64 persons or more than 16 tons net load; top speed of 350 m.p.h.; range of more than 4,000 miles, low altitude comfort on operations up to 30,000 ft.; economical operating costs. *Airlanes*, April, 1942, pages 14, 15, 23, 2 illus.

Ambulance Plane. A picture survey of the conversion of the Aeronca Super Chief for use as an ambulance airplane, and the manner in which this model can be used as an emergency vehicle. *Air News*, May, 1942, page 4, 8 illus.

Flying Hell. Jim Marshall. This description of the new Vultee Vengeance, its construction and production, is preceded by an explanation of the principles of dive-bomber mechanics. A comparison with the German Stuka and similar types of bombers manufactured by the Japanese contends that the Vengeance can outfly, outdive and outbomb them all. Also given is a brief account of the perfecting processes that the Vengeance and other airplanes must undergo from the first engineering plans until the time they come off the assembly line in quantity. This takes into consideration the reasons why handicraft must play a large part in the construction of the airplane. *Collier's*, May 9, 1942, pages 13, 65, 1 illus.

Short Stirling. Description, dimensions, specifications, and performance standards of the Short Stirling. The four engines of this mid-wing cantilever monoplane are mounted on the leading edge of the wing. These are either 14-cylinder radial air-cooled Bristol Hercules sleeve-valve engines of 1,600 hp. each or American Wright Cyclone engines. Special features of the giant bomber are its speed and range, the former 300 m.p.h., the latter above 2,000 miles. *Canadian Air Cadet*, April, 1942, page 14, 2 illus.

Airports

Airport Legal Developments of Interest to Municipalities—1941. John M. Hunter, Jr., and Lewis H. Ulman. A large volume of state legislation

NEY INVITES ENGINEERS TO EXPLORE THE POSSIBILITIES OF PRECIOUS METAL ALLOYS

FUSION TEMPERATURE °F.	BRINELL HARDNESS		% ELONGATION		ALLOYS	PROPORTIONAL LIMIT p.s.i.		ULTIMATE TENSILE STRENGTH p.s.i.	
	Annealed	Heat Treated	Annealed	Heat Treated		Annealed	Heat Treated	Annealed	Heat Treated
1925	190	270	15	7	Ney Oro #4	86,500	131,500	117,500	173,000
2010	175	275	20	15	Ney Oro #12	88,000	135,000	125,000	178,000
1675	200	290	14	1	Ney Oro G-C	73,000	135,000	120,000	165,000
1750	170	280	27	6	Ney Oro G	77,000	154,000	99,000	160,000
1975	225	260	9	8	Neydium #9	115,000	134,000	148,000	167,000
1970	150	270	24	15	Paliney #6	63,500	127,000	110,000	170,000
1985	180	280	24	9	Paliney #7	89,000	148,000	120,000	180,000
1650	160	268	22	1	Denture Clasp	52,000	122,000	100,000	157,000
2500	95	95	23	23	Paliney M	24,000	24,000	60,000	60,000
1910	105	105	20	20	Ney Oro T	30,000	30,000	63,000	63,000
1660	95	165	22	6	Ney Oro B-20	23,000	58,000	51,000	82,000
1850	45	45	25	25	Ney Oro A	7,800	7,800	31,000	31,000

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SPECIALISTS IN PRECIOUS METAL METALLURGY NEY GOLD **SINCE 1812**

relating to airports was passed in 1941 and several federal statutes were enacted, cases were decided, regulations were promulgated and legal opinions were rendered. These activities are discussed under the general headings of airport development, airport operation and regulation, and airport protection. *The Journal of Air Law and Commerce*, April, 1942, pages 116–139.

Kansas City's Second Municipal Airport. Russell Cantwell. How Kansas City, crossroads of the great transcontinental supply lines from the days of the pioneers, is building the foundation for a vast inland harbor for air transportation is related in this article. The city now has two Class 4 airports and is building a new municipal airport at a cost of $4,000,000, a large part of which fund was accumulated by good municipal management. Eventually, the city will be encircled by five additional Class 3 and Class 4 airports.

A description of the new airport is given, covering location, construction features, transportation facilities, and the airlines and aeronautical schools that will use it. *Aero Digest*, May, 1942, page 94.

Armament

Bombs for Low Level Attack. W. E. Hick. In low level bombing it has been discovered that a serious loss of accuracy is encountered through bouncing or ricocheting of the bomb before it explodes. Because of the added velocity imparted by the aircraft, the delayed-action projectile could bounce higher than the carrying airplane, entailing the risk of the airplane being damaged by collision with the projectile. Two methods for avoiding this risk are suggested. One is to fit the bomb with wings in order to flatten the trajectory; the other is to achieve the same effect by fitting the explosive with a parachute. Methods for sighting this type of attack are suggested. *Aeronautics*, April, 1942, pages 20, 21, 3 illus.

Air Arms of World War II. Sectional drawings, application data and technical descriptions of the standard types of ammunition used in modern air warfare, and typical installations of the various types of machine guns and aircraft cannon in current use. Full-size pictures of standard ammunition, of 0.30- and 0.50-caliber machine-gun ammunition and 20- and 37-mm. explosive shells are also given to show their comparative size. *Air News*, May, 1942, pages 14–18, 14 illus.

Self-Steering Aerial Torpedoes and Bombs. Brief description of a British invention enabling projectiles to be dropped directly on targets. This device, in the form of a tiny pilotless aircraft, complete with engine, airscrew, gyrostatic controls and other equipment, permits aerial torpedoes, bombs and shells to steer themselves to their target under their own power. The cost of manufacturing 40-lb. units is said to be cheaper than that of artillary shells. *Commercial Aviation*, April, 1942, page 40.

A Curtiss Kittyhawk fighter mounted in flying position on the firing range at Buffalo.

Avigation

"Too Many Suns." Douglas Crosby. An investigation into the practice of determining aerial position by astrograph suggests that the student avigator have a background of astronomy as a basis for his astrographic work. Toward this purpose it offers a brief approach to a knowledge of the stars, their names, the constellations they form, how they move, how bright and what colors, and the motion of the moon and sun. *Canadian Air Cadet*, April, 1942, pages 15, 27, 3 illus.

Business and Finance

Parts Firms Seek Tax Aid for Expansion. James L. Straight. Viewing the plight of the aircraft parts and accessories manufacturing industry under the excess profits tax, which is regarded as a barrier to necessary expansion likely to create a serious bottleneck, the writer suggests antidotes in the form of federal aid or exemption from certain provisions of the tax laws. Among the suggested remedies is one to permit the acceptance by the Government, after certification by the W.P.B., of receipted bills for the actual cost of expansion in lieu of cash in payment of excess profits taxes. Outright Government grants instead of loans, tax benefits for established plants as opposed to facilities converted from more profitable industries, and Government loans of idle tools taken from unconverted industries are among other suggestions made. *American Aviation*, April 15, 1942, page 14.

Congress Okays Bill for 31,070 Planes. Katherine E. Johnsen. Congressional action is reported on the sixth supplemental appropriations bill providing $8,515,861,251 for the Army Air Corps, $424,827,000 for the Navy Bureau of Aeronautics, $7,009,720 for the C.A.A. and $3,500,000 for the N.A.C.A. Other features of the bill noted are that it makes possible the addition of 31,070 airplanes to the nation's air power, permits the renegotiation of contracts to control profits and allows an increase for the C.A.A. *American Aviation*, April 15, 1942, page 4.

Airlines Rank High Among Railroads in Passenger Revenues for 1941. A study of the reports of leading railroads and airlines to the Interstate Commerce Commission is presented, revealing that in passenger revenues the major domestic airlines retained their ranking positions in 1941, despite wartime conditions that

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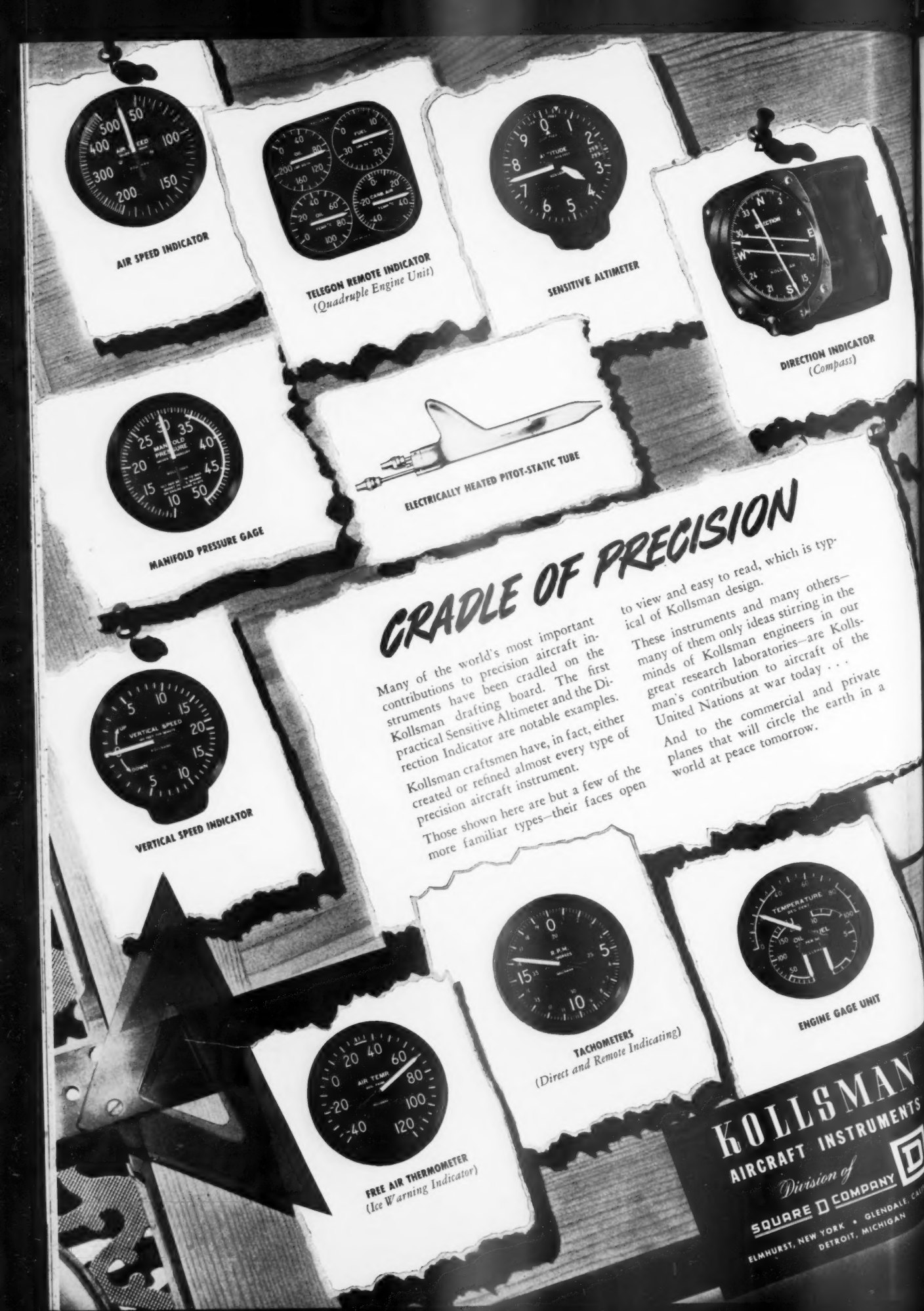
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brought restrictions for the airlines and a great increase in traffic for the railroads. American Airlines had a 30 per cent gain over 1940 and moved into eighth place among the railroads, United Airlines gained 21 per cent and took twelfth place, Eastern Air Lines had a 31 per cent increase and ranked sixteenth, while T.W.A. reported a 29 per cent upturn and ranked twentieth. In revenue passenger-miles, domestic air transportation has been gaining steadily since 1935 by comparison with Pullman mileage, rising to 13.7 per cent of the total in 1941, against 3.9 per cent in 1935. *American Aviation*, April 15, 1942, pages 3, 35.

Civil Air Defense

CAP Credited With Successful Anti-Submarine Work in Atlantic. A news account of the recent activity of the special task force established by the Civil Air Patrol to supplement the Army and Navy patrols. This unit was recently credited in Army statements with aiding in the location of several enemy submarines off the East Coast. The article further indicates the larger number of tasks, such as courier service and patrol missions, which the 40,000 volunteer members participate in, thus contributing to the war effort. *American Aviation*, May 1, 1942, page 6.

Civil Aviation

Making the Airplane Behave. Wolfgang Langewiesche. Attributing the majority of light airplane fatalities to stalls and spins, the writer explains the causes of these phenomena and the design changes that are being made by airplane manufacturers to eliminate the dangers mechanically. It is his contention that merely teaching pilots how to avoid stalls is not foolproof and that the engineering principles of the airplane construction itself must make them impossible. When that is done, he concludes, piloting will become more nearly universal and the airplane will be as much a convenience of everyday life as the automobile. The Stinson 105, the Ercoupe and the tricycle landing gear are indicated as strides in this direction. *Harpers*, May, 1942, pages 620–629.

Civil Flying After the War. C. G. Grey. Speculations on the manner in which civil aviation may be developed after the conclusion of the present conflict are introduced by a review of the past operations of independent air transport lines in the British Isles and their gradual consolidation into large systems. The possibility of an international air transport service is explored on the basis that the nations of the world will have to work together for the reconstruction of business and political activities.

Individual flying is considered in relation to the financial ability of the average citizen to own and operate a private airplane after the war and his desire to resume flying even if some cooperative plan has to be worked out through clubs or with Government aid. Small companies operating aircraft for charter are also suggested, to be patronized by parties desiring to go touring. A plea for the development of safe civil flying is voiced and it is shown that excellent airliners can be obtained as a result of the construction of large fleets of troop-transport airplanes, which the writer advocates at once. *The Aeroplane*, March 20, 1942, pages 326–328, 3 illus.

The Future of Civil Aviation. "Planthair." The second article of this series explores the possibilities of establishing civil aviation on a basis of international cooperation after the war. An international clearing house is suggested to avoid unnecessary competition and to afford a means for the exchange of technical information and for the maintenance of international standards in licensing, signals, airworthiness and other matters of like nature. Similar considerations prevail with respect to internal services and to the development of transport operations within the British Empire. It is held that public service should be the determining factor in both national and international policies and that transport lines should not be started unless they have a good chance to survive. Government subsidies are given consideration, as well as questions concerning the advisability of operations by a single large company or whether the work should be subdivided among a number of organizations. *Flight*, April 9, 1942, pages 338, 339.

The Future of Civil Aviation. "Planthair." That the importance of civil aviation is at last being realized in Great Britain is emphasized, particularly with regard to the reconstruction period after the war. A contrast is drawn with conditions in the United States, where it is said that civilian air training has been expanded and used to help in the war effort, and in Britain, where it seemed to be the official desire to stamp it out as quickly as possible. However, it is indicated that civil aviation is now recovering and is likely to be allowed to perform a useful function.

The history of British civil aviation is reviewed briefly and the opinion is expressed that the muddled state of affairs prevailing in recent years must be quickly corrected. Recommendations are made for the reorganization of the governmental control of civil aviation, including the appointment of an authoritative body, such as a Royal Commission, to establish a broad policy and carry it into action. *Flight*, April 2, 1942, pages 324, 325.

Design

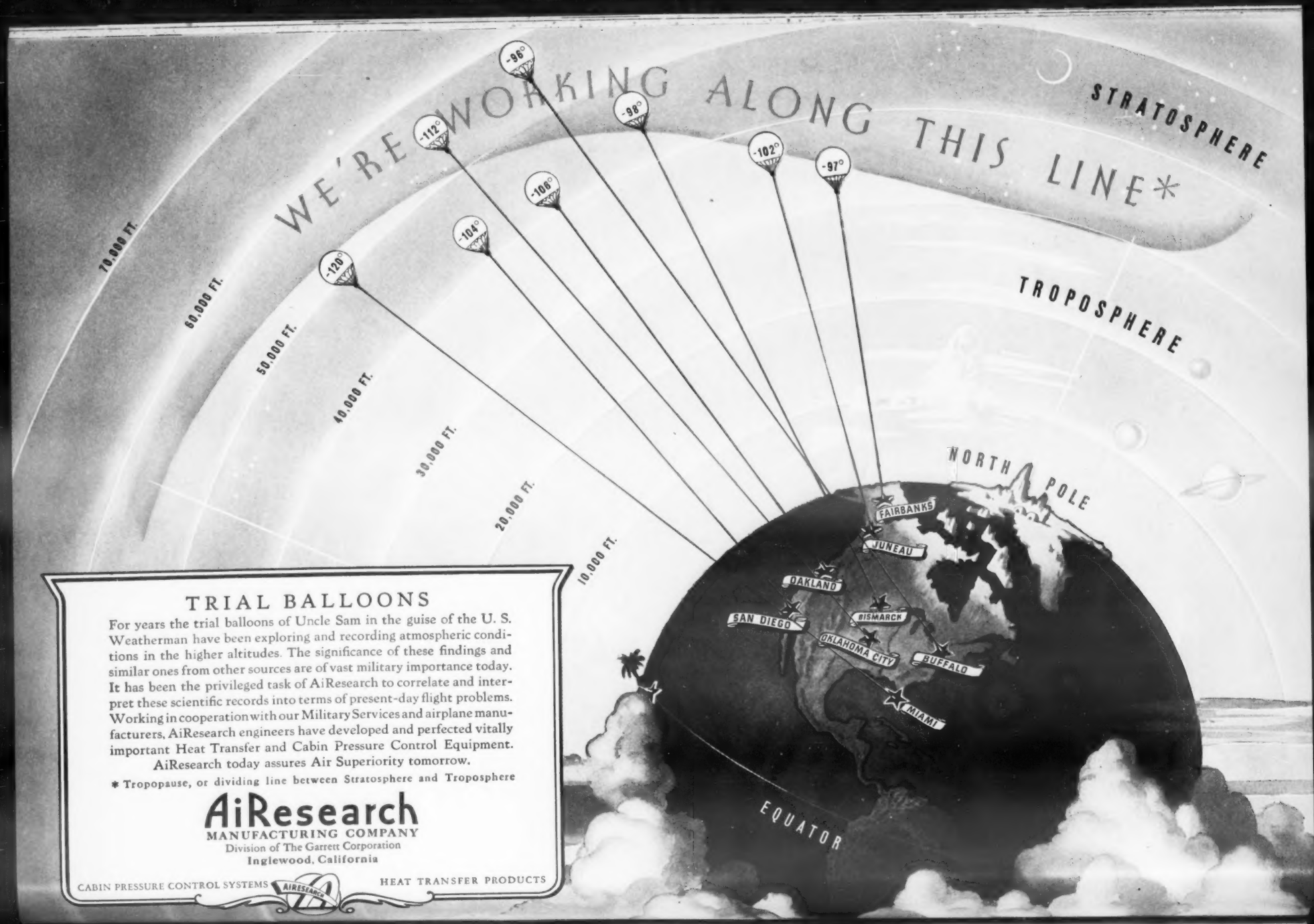
Power Planting. The evolution of engine mountings, propeller arrangements, number of engines and power plant position are considered in the light of better visibility, decreased frontal area and improved weight distribution. The conclusions arrived at since the pioneering days indicate, according to this article, that the ideal airplane design is not as yet in view. *Flight*, March 19, 1942, pages 249–255, 21 illus.

The Articulated Undercarriage. H. G. Conway. An examination of the development and advantages of levered undercarriages for main or tail wheels. The conclusion drawn is that although their general adoption is likely to be restricted by their weight they are efficacious where the sliding friction of a normal unit would be excessive. Diagrams demonstrate the construction and mechanics of various types of articulated undercarriages and tail wheels. *The Aeroplane*, March 20, 1942, pages 336–338, 10 illus.

Simplicity—Replacing Art. James E. Thompson. A study of the simplifications in design and construction which have been made in the light of two years of actual warfare. Many aerodynamic advantages and performance gains have been abandoned, according to this article, in favor of fire superiority, ease of maintenance and simplicity of construction. *Western Flying*, April, 1942, pages 192–196, 4 illus.

Lofting Problems of Streamline Bodies. Part 6. Carter M. Hartley and Roy A. Liming. This installment treats the close functional relationship of the tangents to those construction techniques which are applicable to the second-degree curve development. *Aero Digest*, May, 1942, pages 249, 250, 271, 6 illus.

Remote Propeller Drives. Frank T. Courtney. Wartime demand for optimum performance of aircraft has caused many designers to re-examine the possibilities of "piping" power from engine to propeller by means of mechanical, hydraulic and electrical devices. This article studies the past history of remote propeller drive, scrutinizes the advantages and drawbacks of all three possible methods and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speculates on the possible changes in design which may be effected through the exploitation of remote propeller drive. *Aviation*, May, 1942, pages 82–85, 247, 6 illus.

Topical Aircraft Problems. Gunther Bock. The first installment of the translation of a paper delivered last December before the Lillienthal Gesellschaft on the problems currently confronting airplane designers and some of the recently reached solutions. This installment discusses performance and wing loading, boundary layer control, direct fuel injection turbo-blowers and ejector exhausts.

Part II takes up the matter of pressure cabins, heating arrangements and the airflow around the wings at speeds approaching that of sound. Results of compression and the drag of the airframe are considered, as well as the effects of such speeds on the propeller and its performance. The magnitude of the control forces is calculated and the discussion turns to the structural strength of the fuselage and the risks of flutter. *Flight*, March 26, 1942, pages 289–294, 15 illus.; April 2, 1942, pages 315–319, 13 illus.

Northrop's Flying Wing. Persis Cassiday. A description of the tailless bent-wing-tip airplane being developed by Northrop Aircraft, Inc., which, it is predicted, will yield substantial increases in range, speed and economy in production and operation. Description is limited because of censorship restrictions and the accompanying photograph has been retouched to eliminate disclosure of the wing control mechanism. *Airlanes*, April, 1942, pages 4, 5, 1 illus.

Five Years From Now. Drawings given out recently by the United States Army Air Corps foreshadow what may be expected of the airplane that will be in production five years from now. This article discusses the general trend of development that design is now taking and uses for illustration several models that are providing engineers with the basis for study of aerodynamics, armament power and performance of future military planes.

Among the points stressed are: all but one of the advanced designs released have pusher-type propellers; some of the bombers have as many as eight engines; one fighter is tailless, has wing-tip rudders, and the gunner sits back-to-back with the pilot; experimentation with more powerful gasoline engines predicts that they may even surpass 3,000 hp.

The Snipe, the Bat, the Windmill, the Canard, the Shrike, the Air Whale, the Eagle, and the Thunderbolt are the prototypes shown. *Canadian Air Cadet*, April, 1942, pages 16, 17, 21, 7 illus.

British Ministry of Aircraft Production's Notes on the Structure of German Aeroplanes, Part II. Continuation of a series of articles describing German Junkers aircraft. Part II offers a superficial examination of the complete Ju 88 A-6, comparing it with the Ju 88 A-1 and the Ju 88 A-5. The opportunity is taken to note several modifications on the more recent Ju 88 types which, it is claimed, have not yet been reported. Details are given on the aerodynamic features, the airframe, engines, engine controls, lubrications system, fuel system and cabin and wing leading-edge heating systems. Diagrammatic sketches help to clarify the text. *Commercial Aviation*, April, 1942, pages 28–30, 32, 34, 8 illus.

Engines

The Control of Torsional Vibration in Radial Aircraft Engines by Means of Tuned Pendulums. Vincent Moore. Since the presentation in 1936 of the fundamental theory of the tuned pendulum or dynamic damper as a means of controlling crankshaft torsional vibration, the Wright Aeronautical Corporation has done extensive development and test work on this device, finding it most effective. The dynamic damper has also been applied to the crankshaft of in-line engines with satisfactory results although the design problem for an in-line crankshaft is generally a more difficult one than for the usual single row radial engine crankshaft.

The success of the dynamic damper as applied to the radial aircraft engine has been so great that it leads many people to believe that it is a cure-all for torsional vibration problems and that at the first sign of difficulty it is only necessary to tack on a damper to overcome it. In general, however, the design of a suitable dynamic damper requires a careful study of the characteristics of the crankshaft-propeller system and the disturbing orders in order to determine the location and the tuning of the necessary dampers to control the crankshaft vibration. It may be shown that the application of a damper to the shaft at some points will produce no improvement at all and that the indiscriminate application of a damper tuned to a prominent disturbing order may prove disastrous by building up a resonant condition with some other disturbing order acting on the system.

This paper contains notes on some of this work under headings discussing the crankshaft-propeller system, the disturbing torques and the crankshaft motion. The theory of the tuned pendulum is analyzed and consideration is given to the influence upon vibratory amplitude of damper tuning and of disturbed frequency. The flexibility of the crankshaft is a factor entering into the calculations. Mathematical formulas are developed for a double damper crankshaft and for a single damper between propeller and crank throw. Transient conditions are also taken into consideration. *Journal of the Aeronautical Sciences*, May, 1942, pages 229–244, 16 illus.

Suggestions for the Post-War Steam Aeroplane. Advantages of steam power for use in airplanes include silence in operation, economy, safety, stored energy and ability to fly at high altitudes without loss of power, according to the writer of this article, who goes on to speculate on the particular form of steam power plants of the future. For the larger aircraft it is suggested that the Huettner type of combined boiler turbine or the Doble system as used in the Besler machine may be suitable, the latter having been demonstrated by actual flights in California. For civil aviation and light airplanes, several existing methods of steam generation are explained and their applicability to aircraft is discussed. The Serpollet system has the advantage of accurate measurement of fuel and water delivered to the burner, and the fuel tank can be replenished without extinguishing the fire. The Turner-Miesse system has the benefit of a fully enclosed burner that would not be affected by following or cross winds, and offers great fuel economy. The Stanley system is featured by a large reserve of stored power that would permit of sustained flight for a considerable period after the burner has been turned off, an important safety factor in event of fuel exhaustion. Some of the drawbacks in the form of weight and delay in getting up steam are offset by the natural advantages of ample airflow for condensation, the constant load offered by an airscrew and other factors that make steam a satisfactory power medium in the opinion of the writer. Special advantages are claimed for coke as a fuel. *Steam Car Developments and Steam Aviation*, January-February-March, 1942, pages 17–19.

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Aircraft Engines by Buick. A machinist's examination of the production process by which the Buick Motor Division of General Motors builds radial air-cooled aircraft engines. The article indicates many of the operations in which automotive practices were applicable to the more complicated process of building aircraft power plants and many others where orthodox aircraft procedures had to be retained in order to maintain close tolerances. The general shop procedure and general precautions required for adapting automotive labor and machines to this special task are included in this presentation. *American Machinist*, April 30, 1942, pages 394–403, 18 illus.

Britain's Rolls-Royce Merlin XX Engine. M. W. Bourdon. Incorporating a comparison of the Rolls-Royce Merlin X with the more powerful version of the same design known as the Merlin XX, this article, illustrated by British official photographs, gives specifications in considerable detail of the engine, its parts and accessories. *Automotive and Aviation Industries*, May 1, 1942, pages 36, 37, 3 illus.

How Packard Builds Rolls-Royce Aircraft Engines. Joseph Geschelin. Application of mass production methods to the building of aircraft engines entailed problems of tooling, plant design and precision workmanship not encountered in the conventional practices involved in building high-grade passenger automobiles. The methods and machinery used by the Packard Motor Car Company in assuming its assignment to manufacture Rolls-Royce aircraft engines are detailed in this article. The uncommonly rigid requirements as to quality of finish and perfection of dimensional tolerances demonstrated the fact that there is little similarity between an in-line, V-type liquid-cooled engine and the passenger car engines formerly built in these plants. The manufacture of thousands of parts which must be finished to extremely close tolerances and under exacting quality controls required machines to greater rigidity and more massive fixtures than those used in automobile production because accuracy and alignment must be preserved. Further complication arose through the necessity for special heat-treating and corrosion-resistant treatment of nonferrous parts.

How Packard made a searching analysis of these requirements, rearranging and adjusting existing machinery where possible and providing new buildings and machinery where necessary, is set forth in considerable detail. Processes used in the manufacture of various individual parts are presented, together with information on the makes and types of machine tools used. The procedures involved in the initial assembly, "green" test run, disassembly, inspection, reassembly and final test are covered. Photographs show numerous views in the shops. *Automotive and Aviation Industries*, May 1, 1942, pages 20–25, 11 illus.

Single-Stage Supercharged Engines. Donald S. Hersey. To answer questions relating to the applicability to supercharged engines of power-correction formulas for naturally aspirated aircraft engines, the writer has developed a new formula taking into account various test-stand and flight conditions. The working out of the formula is described, along with the tests made at altitudes up to 18,000 ft.

The subject is treated under headings covering the scoop effects and supercharger effects on the inducted air; the intake-manifold effect on the state of the inducted air; volumetric efficiency variations with atmospheric changes; mixture strength and specific air consumption variations with atmospheric changes; atmospheric moisture-content effects; engine-speed variations with atmospheric changes; and atmospheric effects on friction horse

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power of a single-stage engine. The formula thus evolved is set forth for single-stage engine full throttle power correction, with the statement that thorough experimental checks showed that the correction error of the new formula is about 1.5 per cent. Experimental work was done with a Pratt & Whitney R-1830 engine and a Vultee AB-2 airplane. *Automotive and Aviation Industries*, April 15, 1942, pages 28–34, 7 illus.

American Aircraft Engines. Descriptions, dimensions, performance and construction data on the currently built types of U.S. military and civil power plants. *Western Flying*, April 1942, page 156 and alternate pages to 182, 33 illus.

The Bristol Hercules. Part III. J. A. Oates. Exposition of final assembly and testing methods forms the crux of this concluding installment in a series of articles on the manufacture of the Hercules engine. Details are given about the production of major Hercules components, as well as descriptions of the more important laboratories and process sections. The portion of the article devoted to laboratories and standards rooms indicates how a close check is kept on everything concerning the engine and the equipment used for its production. *Aircraft Production*, April, 1942, pages 303–310, 19 illus.

America's Allison Engine. G. Geoffrey Smith. Structural and operational description of the Allison 12-cylinder V-type, 1,710 cu.in. aircraft engine, giving its general features, lubrication, accessories, carburetion and general service instruction. *Flight*, March 20, 1942, pages 281–284, 7 illus.

"Bristol" Built. A description of the evolution of the long line of air-cooled radial airplane engines terminating in the highly specialized Hercules engine for R.A.F. bombers and fighters. Particulars of the 1,600 hp. Bristol Hercules 14-cylinder, two-row radial engine are explained in a detailed drawing. The article is also accompanied by a factual chart giving the basic types of Bristol air-cooled engines from 1918 to 1942. The chart covers engine, type, maximum output (power, r.p.m., altitude), overall diameter, dry weight, capacity, power to weight ratio, year, and representative types of airplanes in which the engines are installed. *The Aeroplane*, March 13, 1942, pages 296–300, 4 illus.

Brazil to Build Aircraft Engines. Details of an agreement between the United States of Brazil and the Wright Aeronautical Corporation under which the first aircraft engine company ever operated in Brazil will manufacture Wright Whirlwind engines of seven and nine cylinders, ranging from 235 to 450 hp. Specifications for all engine parts will be supplied to Brazilian specialists and—with the aid of the engine company's technical staff—these South American firms will be trained to produce forgings and other engine materials to meet aircraft engine specifications. *Airlanes*, April, 1942, pages 2, 3, 19, 5 illus.

Power on High. Constructional and engineering data on the Ranger engine, manufactured by the Ranger Engine Division of Fairchild Engine and Airplane Corporation. This presentation announces as official the fact that, contrary to rumor, Ranger engines will not be manufactured in Canada. *Commercial Aviation*, April, 1942, pages 74–77, 10 illus.

Flight Testing

Coast Guard Tests the Grumman. A camera study of the routine acceptance tests through which a twin-engined Grumman amphibian is put before the U.S. Coast Guard will accept it for service. These tests include performance, land and water handling and fuel consumption, as well as structural sturdiness. *Air News*, May, 1942, pages 30, 31, 7 illus.

Gliders

Icarus Antarcticus. Leighton Collins. The author's account of his first flight in a glider is supplemented by his analysis of the principles of soaring. *Air Facts*, May, 1942, pages 58–65, 5 illus.

Gliding and Soaring

Soaring Comes of Age. Charles T. Malone. The second of two articles by the President of the American Glider Association attesting to how the development of new aerial techniques utilizing gliders is contributing to the war effort. This installment treats mainly of its use in connection with the pilot training program. It also contains a prediction of the place gliding will take in aviation after the war. *Flying and Popular Aviation*, June, 1942, pages 53, 98, 100, 1 illus.

Gliders and Sailplanes. Pictures, three-view drawings, dimensions, specifications and performance data on the approved types of military and civilian gliders and sailplanes being manufactured in the United States. *Western Flying*, April, 1942, pages 152, 154, 9 illus.

Gliders in War Paint. Vernon Pope. Demonstrating that definite incorporation of gliding into the aerial war programs of the United States and Great Britain is following recognition of its value, this analysis lists the advantages of gliding for training and combat service. For training, it is said, practical flight tests in gliders offer the most nearly accurate means available for determining the capabilities of potential pilots. They also impart a sense of independence and self-reliance to the flying trainee because of the step-by-step method of instruction they offer. In actual warfare, it is pointed out, gliders' silent operation and their ability to make compact landings expedite the air transportation of large numbers of armed soldiers. *Canadian Air Cadet*, April, 1942, pages 7, 26, 2 illus.

High-Altitude Flying

Altitude Is the Thing. A study of the peculiar conditions in the upper atmosphere which have necessitated the development of superchargers and oxygen equipment for the sustenance of the air crews. This article outlines the clinical research that has been conducted by the Mayo Foundation, the Army and Navy on the physical effects of high-altitude flying and the manner in which the problem of providing oxygen for pilots in case they have to abandon the aircraft via parachute at high altitudes was solved by designing a "bail out" bottle and special breathing harness. *National Aeronautics*, May, 1942, pages 10, 11, 3 illus.

History

34 Years of Air Power. T. Benson Hoy. A study of the growth of military air power from the first military adaptation of the airplane as a weapon carrier to the present. It indicates the constant struggle that the advocates of air power had to conduct against the reactionary, traditional soldiers. *Western Flying*, April, 1942, pages 38–41, 10 illus.

The Air Pioneers to Australia. An account of the flight 14 years ago from Oakland, Calif., to Sidney, Australia, by the late Sir Charles F. Kingsford-Smith and his companions in the Fokker trimotor, Southern Cross. *Western Flying*, April, 1942, page 184, 6 illus.

Hydraulics

Castor Oil Base Hydraulic Fluids. A. H. Shough. The properties of various blends of castor oil and solvents are compared with samples of commercial hydraulic fluids for such important considerations as their corrosiveness on metal, attack on rub-

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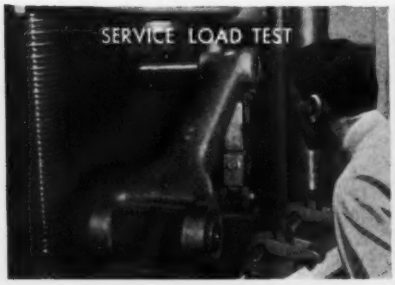

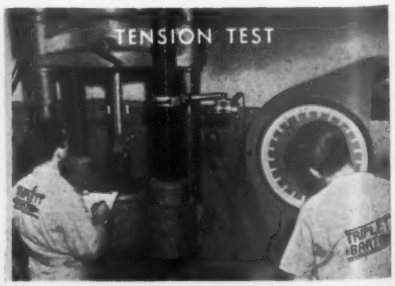

ber, pour point and volatility of solvent. *Industrial and Engineering Chemistry*, May, 1942, pages 628–632.

Icing

Carburetor Ice. Robert N. Buck. A consideration of carburetor ice which tells what are its causes under various temperatures and advises how to prevent it under various given conditions. The admonition is given that summer, not winter, is the time to be most wary of iced carburetors. *Air Facts*, May, 1942, pages 31–36.

Jet Propulsion

Jet Propulsion. Alexander Klemin. Illustrated by a sectional drawing showing the essential parts of the Campini jet-propulsion aircraft, this brief article describes its operation in nontechnical language. *Scientific American*, May, 1942, page 254, 1 illus.

Maintenance

Aircraft Maintenance (Part 2). W. E. Koneczny. The second installment on airplane maintenance handles the correct procedure in inspecting, repairing and replacing parts of the cable, control and control-surface system of the modern airplane, explaining the special conditions that are conducive to specific types of deterioration in the airframe. *Aero Digest*, May, 1942, pages 164, 261, 264, 2 illus.

Crashed Planes Fly Again. For every hundred aircraft built of new materials, this article states, the Royal Air Force gets 60 more built entirely of parts salvaged from damaged aircraft. This account outlines the structure of the Repair and Maintenance Department of the R.A.F., indicating the procedure followed in separating the usable parts and relegating the rest to remelt. Captured and crashed enemy aircraft are similarly handled. Some interesting facts on the procedures developed for the R.A.F. maintenance of American airplanes are also presented. *Aero Digest*, May, 1942, pages 88, 91, 7 illus.

Primary Flight Maintenance. William D. Strohmeier. A study of the maintenance technique evolved by the Hawthorne School of Aeronautics, a typical civilian flying school now training Army pilots under contract. *Aviation*, May, 1942, pages 187, 189, 248, 5 illus.

Maintaining the Americans. To meet the special requirements involved in the maintenance and repair of aircraft and engines made in the United States and supplied to the British forces, a large plant has been established in England in which training is given in these operations. The establishment and development of this school of repair and maintenance are traced, showing how thousands of expert mechanics were evolved from unskilled or semiskilled workers. Specialized instructors were chosen for their aptitude and knowledge of the American products and others were brought in from the R.A.F. until now the personnel is about half service and half civilian.

Ground crews give a preflight check to a Douglas B-19.

Instruction is given in the major differences in design and construction between the British and United States aircraft, engines and accessories which are found mainly in the matter of compression pressure, fuel injection, carburetion, landing gear and the hydraulic and electrical systems. Courses are available on Pratt & Whitney, Wright and Allison engines, Curtiss and Hamilton propellers, Stromberg and Holley carburetors, Curtiss, Douglas, Glenn L. Martin, Stinson and Vought-Sikorsky airframes and on hydraulic and electrical controls. The lessons learned in the school are applied at once in the main repair plant and in the operational stations. *Flight*, April 2, 1942, pages 305–307, 9 illus.

Materials

Ready References for Quickly Calculating Weights. Clarence Dorsett. This article reproduces a series of aircraft data sheets giving the weights of various standard aircraft materials in order to reduce to a minimum the amount of time drawings must stay in the weight section. *Aero Digest*, May, 1942, pages 184, 187.

Properties and Uses of Resistoflex. W. Mac William. A synthetic resin-lined hose for instrument, oil, hydraulic and fuel lines is described as a replacement for synthetic rubber-lined hose and is said to have the added virtue of being impervious to benzol-blend fuels. The hose has an inner tubing of Resistoflex PVA material. The ingredients and methods of making that material are discussed, along with applications of the hose for aircraft construction. Tables are included, giving its properties. *Aero Digest*, May, 1942, pages 229, 260, 3 illus.

Stoves!!! for Tomorrow's Planes. A study of the application of welded low-carbon steel and plastic-bonded plywood to the manufacture of North American trainers, constituting a part of a campaign to build noncombat types of aircraft of nonstrategic materials. The alterations in design and structure necessary for the adaptation of these materials are described. *Western Flying*, April, 1942, pages 186–190, 3 illus.

Substitutes for Rubber and Silk. Edward Engel and Joseph Steel. A survey of the properties of "V" Plastics, developed by Colonial Alloys Company to provide synthetics for rubber and silk in conformation with specific aircraft needs. Compared with the natural compounds, the "V" Plastics are said to be less penetrable and to offer greater resistance to sunlight and aging, abrasion, oils, gasoline, fuels and coolants. In suggesting uses for the several types of these plastics, it is indicated that in some instances they may have technical improvements over the natural products while in others they are merely offered as expedients or alternates. Tables listing the size limits, as well as the mechanical and physical, general, chemical and thermal properties, of this group of plastics are included in the article. *Aero Digest*, May, 1942, pages 212, 214.

Degreasing Process. J. L. Murphy. A general discussion of the problems involved in the removal of grease from the surface of aluminum alloys and other nonferrous metals, indicating that while kerosene and mineral seal oil, either hot or cold, will remove the bulk of a grease surface easily the solvents themselves leave a grease film that is not easy to remove. The writer describes two new products, one a dry compound and the other a method for making kerosene and mineral seal oil water-soluble as an aid to fast degreasing. *Aero Digest*, May, 1942, pages 232, 260, 275.

Conserving Aluminum Scrap. John St. Peter. This writer points out that a large percentage of the industry's metal requirement could be supplied through the careful reprocessing of scrap metal. Contamination,

it is indicated, is the greatest enemy of this program. This article suggests a system for segregation beginning at the preproduction stages, indicating that the first conservation measures should be taken by the purchasing department and by proper design for the most economical use of the metal. *Aviation*, May, 1942, pages 99, 101, 2 illus.

La Corrosion En Los Materiales De Ingenieria Aeronautica (Corrosion of Materials Used in Aeronautical Construction). Juan B. De Nardo. This second article of a series deals with corrosion of aeronautical construction materials. The primary factors in determining the usefulness of a certain material in aeronautical construction are set forth as the correct combination of the physical and mechanical properties of a material that has to serve a certain purpose and its capacity to retain these properties beyond a determined minimum value and for a certain period of time. Therefore, tests, especially corrosion tests, are necessary.

Results of many tests made by Borgmann are presented. The writer then considers cases of corrosion which take place during service, their causes and their prevention. The conclusion is drawn that the three main causes are poor surface protection and noninsulated joints, accumulation of dampness at certain points in the parts, and dissimilarity of materials that come in contact with one another. An instance of the last-mentioned factor is that of aluminum alloys coming in contact with other metals. As a precaution he recommends proper insulation and provision to eliminate the accumulation of dampness. *Avia*, January, 1942, pages 7–11, 12 illus.

Saving Tin. As a contribution to the need for tin economy T.M.5 is presented, a suggested substitute that is stated to be particularly suitable for bit soldering on tinplate. This lead-base alloy containing 5 per cent tin was introduced by Fry's Metal Foundries, Ltd. In comparison with standard alloys two of its distinguishing features are a higher melting point and a lower alloying power because of reduced tin content. The article indicates how the influence of these two characteristics varies with hand soldering, blowpipe soldering, machine soldering and hot dipping. Tables give the melting points of various solders, dipping temperatures and strength of lap joints. *Aircraft Production*, April, 1942, page 276.

Why Are We Short of Aluminum? Henry W. Roberts. Calling aluminum the most common metal in the world and stating that one-twelfth of the earth's substance consists of aluminum, the writer gives statistics covering the production of the metal and the available sources of the bauxite and alunite ores, followed by descriptions of the processes by which the metal is produced.

The shortage of aluminum is attributed in part to the limited amount of shipping space available for bringing the ores from overseas countries where it is plentiful and, primarily, to the lack of sufficient electric power for the reduction and manufacturing operations by which the ore is converted into useful form. *Scientific American*, May, 1942, pages 232–234, 3 illus.

Medicine

Maintenance Men. William Flynn. A presentation of the manifold duties facing the flight surgeon whose job it is to keep pilots and air crews not only physically but psychologically fit for flying. One section of the article is devoted to the physical requirements for Air Corps entrance, the ex-

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amination a candidate must undergo and what defects may be corrected. Another dwells on the prophylaxis for adverse mental attitudes and depletion of nervous energy and the flight surgeon's checkup on conditions contributing to maintenance of morale. In conclusion, the emergencies that the doctor must face are depicted and mention is made of their further contribution to "keep 'em flying" by their studies of the blackout and the use of oxygen in high altitudes. *Air Facts*, May, 1942, pages 22–30.

The Problems Inherent in the Protection of Flying Personnel Against the Temperature Extremes Encountered in Flight. Otis A. Benson, Jr., and Ernest A. Pinson. Solution to the problem of maintaining heat balance in the bodies of persons engaged in flying under the rapidly changing conditions of environment and at the extremely low temperatures encountered at high altitudes has progressed along three rather logical and distinct pathways. Each mode of solution is discussed together with its individual merits and objectionable features. This is followed by an analysis of the future possibilities of each of the various trends in relation to the final solution of the problem.

The final solution to the problem of maintaining body heat balance under the varied and extreme conditions encountered in flight is probably dependent to a great extent on future developments in airplane design. If pressure cabin airplanes are developed, the solution may lie in the heating of the cabin air together with some effective means of defrosting window areas in the cabin. As for the present, the best solution would seem to incorporate the best features of the electrically heated suit with the use of insulative clothing of maximum bulkiness commensurate with normal personal comfort and efficiency. Insulative clothing of moderate weight such as the standard intermediate winter flying clothing, can be tolerated on all body areas except the hands which are needed for tactile operations. To keep the extremities warm and the body as a whole in heat balance, external heat could be applied with proper distribution beneath the insulative clothing. Heavy mittens could be carried as accessories or emergency equipment for protection in case of failure of the heating system or abandonment of the ship. This would provide adequate emergency protection, independent of the ship, for all except the most severely cold environmental conditions such as those encountered at very high altitudes and in the far north. *Journal of the Aeronautical Sciences*, May, 1942, pages 252–254; *The Journal of Aviation Medicine*, March, 1942, pages 43–52, 2 illus.

The Ability to See Low Contrasts at Night. Matthew Luckiesh and Frank K. Moss. The development and standardization of tests for determining the ability of military personnel and others to see under conditions often encountered in night flying and in the event of blackout are the subject of this paper. The Luckiesh-Moss Low-Contrast Test-Chart is described and its use is discussed. It is concluded that no single low-brightness level is ideal or entirely free from criticism from both theoretic and practical points of view. With this in mind a brightness level that minimizes the time required for the test and still yields adequate information is the most practicable. *Journal of the Aeronautical Sciences*, May, 1942, pages 261–263, 2 illus.

Sinus Relief via Aviation. Dr. A. C. Ivy and Dr. Louis Krasno, as told to A. W. Bernsohn. An explanation of the new treatment for sinus relief that has been developed by high-altitude medical research. This includes a description of the tank, simulating high-altitude conditions, which is used in the treatment. The basic theory of the work is that to treat sinusitis drainage must be caused and air let into the sinuses; the low pressure at about 10,000 ft. causes the doors of the sinus openings to enlarge, letting air in and fluid out, and the suction naturally created by low pressure at high altitudes draws out the fluid.

The tank, developed for these experiments, has also proved useful for other work, such as in the selection and training of pilots, the testing of oxygen masks and other applications. *Flying and Popular Aviation*, June, 1942, pages 47, 48, 96, 98, 2 illus.

Ever Have "The Leans"? Harold G. Crowley. The Reports Editor of the Safety Bureau of the Civil Aeronautics Board reveals the results of an inquiry into the causes and effects of this false physical sensation or type of vertigo that sometimes affects even experienced pilots when flying by instruments. *Yankee Pilot*, April, 1942, pages 10, 14.

Metallurgy

The Drawability of Deep Drawing Sheets. Part IV. M. Asimow and J. N. Crombie. The fourth installment of this paper takes up the matter of the differences of the rupture strength of metals as determined experimentally compared with the values obtained by theoretic calculations. Certain aspects of rupturing appear to be applicable to the deep-drawing process, upon which basis speculations are advanced which, while purely hypothetic, would seem to offer a partial explanation of various types of rupturing. These conjectures are amplified by a consideration of some hypothetic stress diagrams in which the stress is related to the work of deformation instead of being related to the strain. Instances of uniaxial, biaxial and triaxial tension are given as illustrations, and results of the introduction of the Bauschinger Effect are set forth.

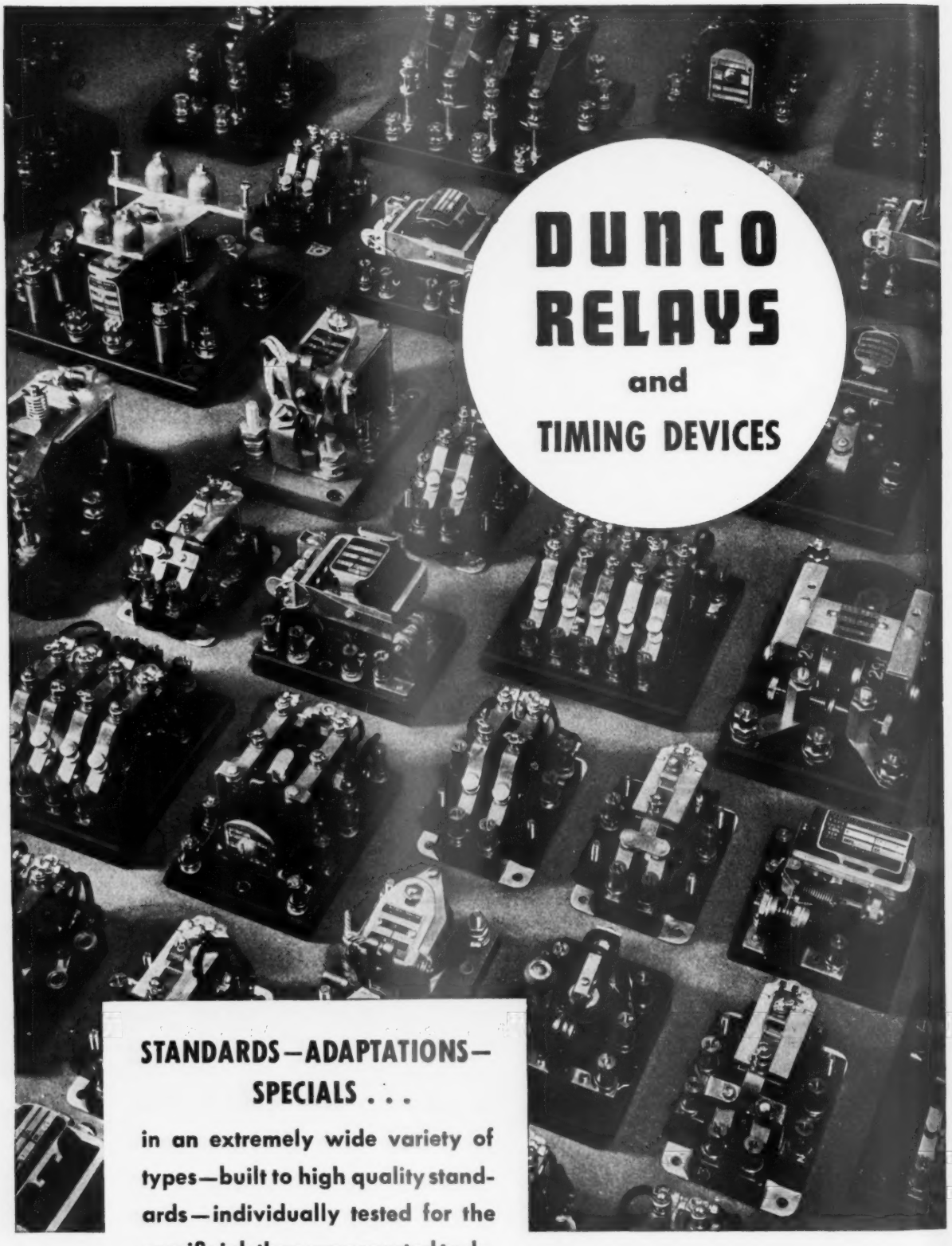
Most research investigations of deep drawing have been confined to small-scale tests. The significance of such tests is clouded because certain factors of great importance in commercial deep drawing are not brought out. However, results of such investigations are reviewed briefly with reference to the increase in thickness of the blank and the formation and prevention of wrinkles. The bibliographic references are continued in this installment. *Heat Treating and Forging*, April, 1942, pages 182–185, 1 illus.

Meteorology

All About Altitude. A table showing the effects of height on the various properties which influence the performance of an airplane. *The Aeroplane*, March 27, 1942, page 361; *The Aeroplane Spotter*, March 26, 1942, page 77.

Pertinent Notes on Safe Aircraft Operation During Spring. Paul A. Gareau. This article is intended to serve warning that some of the most hazardous flying conditions which airmen encounter occur during the transition from winter to spring. The conditions that produce cyclones, high and violent winds, thunderstorms and icing are pointed out. Because of wartime limitation on complete weather information, pilots are warned to exercise unusual care in the selection and observation of flying weather. *Aero Digest*, May, 1942, page 92.

Lightning—and Its Effect on Aircraft. Results are reported of an investigation conducted by E. J. Minser, Chief Meteorologist of Transcontinental & Western Air, Inc., into the phenomena of lightning and its effect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on aircraft. A study of approximately 50 case histories provided a good indication of the origin of electrical charges. Conditions and circumstances conducive to such phenomena are listed and a typical case is described. It is shown that the peak periods for electrical disturbances come in the early spring and late fall. The distribution of the electrical charge in a convective type cloud is illustrated by a drawing. Procedures are recommended under six headings for the avoidance of electrical disturbances and for meeting them when they do occur. *Aero Digest*, May, 1942, pages 122, 134, 1 illus.

La Navegacion Aerea a Traves de las Nubes; La Formacion de Hielo (Flying Through Clouds; Ice Formation). This first installment of a series refers to an article by C. G. Andrus in the April 16, 1928, issue of *Aviation* in which it is said that this subject was scientifically approached for the first time. Special attention is called to subcooled water droplets or subcooled vapor which form ice the moment they come into contact with airplane parts. This ice formation is sudden and therefore dangerous. Clouds that are liable to cause ice formation under certain atmospheric conditions are described together with their characteristics. *Avia*, January, 1942, pages 23–26.

A Pupil's Guide to Meteorology. A brief, nontechnical interpretation of anticyclones, depressions, fronts and precipitations. *The Royal Air Force Quarterly*, March, 1942, pages 104, 105.

Military Aviation

The Turkish Air Force. Rowland Carter. In its strategic position as a neutral nation guarding the land bridge of invasion between Europe and Asia, Turkey has been aided by lend-lease appropriations from America and help from Britain, as well as from Germany, in the building up of her air force. This estimate of her aerial strength not only describes its expenditures, equipment and personnel but also relates its history. Comment is made on Turkey's own aircraft production and the Air League, government-sponsored agency to create airmindedness. Two men mentioned in connection with the advancement of aviation among the Turks are Mustapha Kemal Ataturk, and Staff Major Tekin Ariburun, first air attaché of the Turkish embassy in Washington, D.C. *Flying and Popular Aviation*, May, 1942, pages 26, 27, 84, 86, 88, 5 illus.

American Aircraft in the R.A.F. G. Geoffrey Smith. The editor of *Flight* magazine gives his opinion of what the R.A.F. thinks of the various United States airplanes that are sent over for British use. Although he offers criticisms of several specific features, his comments on the whole are laudatory. Most of the real deficiencies, he comments, occurred in earlier models and have since been corrected. The keen spirit of cooperation existing between American and British personnel, together with the fact that American engineers and specialists are supervising the assembly of United States types, helps to eliminate snags.

He also reviews the procedure of modifying American airplanes for fighting in Britain. *Flying and Popular Aviation*, June, 1942, pages 18–20, 102, 6 illus.

The Curtiss Warhawk fighter. This is the first United States military type to be powered with the new American-built Rolls-Royce engine.

Our New Air Force Is Streamlined. Robert McLarren. An account is given of the reorganization of the United States Army Air Forces into the most powerful striking force in the world. The history of the air arm is traced briefly and the changes that have been made in the organization are outlined. The present divisions and their location are detailed, with the names of the department heads. Information is given on the equipment currently in use, stressing the points of superiority over the enemy's aircraft and armament. *Model Airplane News*, June, 1942, pages 6–8, 53, 54, 56, 16 illus.

The Vickers-Armstrongs Wellington. An outline of the development and operational record of the Wellington Bomber covering its early history and some of its exploits. *The Aeroplane*, April 3, 1942, page 379, 1 illus.

Turkey's Air Arm. V. L. G. Problems encountered by the Turkish Government in the development of its defenses, particularly its air defenses, are discussed. The organization of the Air Arm is described, as well as the schools supported by public and private funds, in which training is given in gliding, parachute jumping and flying. The equipment used for training and for warfare is composed of various types of British, French, Polish and German aircraft, the latter maintained largely by the use of parts taken from German machines shot down by the R.A.F. and furnished to the Turks by the British. *Flight*, April 9, 1942, pages 341–343, 5 illus.

Organization of the AAF. Blaine Stubblefield. An organization chart of the U.S. Army Air Forces, naming many of the key officers and explaining the function of its simplified structure. *Aviation*, May, 1942, page 183, 1 illus.

Russia's Air Force. A cursory study of the U.S.S.R. air force, examining some of the types now being employed on the Eastern Front. The article also explains the structure of the air force administrative system and the chain of 1,100 flying schools which provide the Soviet air armada with adequate personnel. *Indian Aviation*, February, 1942, pages 35, 36.

Annual Survey of Military Aircraft in the United States, Canada, Great Britain. With accompanying photographs of each airplane, this compendium contains information on the

specifications, performance, engines, construction and armament of the American, Canadian and British manufactured aircraft available to combat the enemy. *Canadian Aviation*, April, 1942, pages 33–36, 38 and alternate pages to 84, 107 illus.

Why Not? Lowell Codman. Counseling a generally more liberal consideration of new military ideas, this article advocates the adoption of what is called a "Grasshopper Infantry." This nation's present production facilities and reservoir of light airplane pilots, claims the writer, are sufficient for the basis of a fleet of light airplanes to blanket the sky up to an altitude of 1,500 ft., wreak havoc on enemy concentrations and accomplish an unpredictable amount of psychologic damage. He also contends that the plan possesses value because it has never been done before and that the cost of its trial would be less than the price of one large bomber. *The Sportsman Pilot*, April 15, 1942, pages 6–9, 6 illus.

Model Airplanes

How to Build R.C.A.F. Scale Models. Joseph Woolley. Instruction is given in a system of making scale models which enables model makers to draw their own plans and produce the types desired from three-way silhouettes. The silhouettes provided as examples are four single-engined airplanes—the Supermarine Spitfire, The Bell Airacobra, the Junkers JU 87B and the Messerschmitt ME 109. The equipment needed, plans, actual building, assembling and finishing are outlined in easily followed progression. *Canadian Air Cadet*, April, 1942, pages 10–13, 12 illus.

Naval Aviation

Japan's Naval Air Service. A brief review of the history of the Japanese Naval Air Service from its inception in 1912, its air crew training, and its flying equipment, supplemented by a capitulation of the names and tonnages of Japanese aircraft and seaplane carriers, as mentioned in their 1941 naval yearbooks. *The Aeroplane*, March 20, 1942, page 324, 2 illus.

An Important Job for the Civil Air Patrol. Captain Fred Smith. It is suggested that the Navy's Patrol Torpedo boats, those small, powerful, fast and deadly motor boats which have served so well in the war to date, would be even more effective if each one were equipped with a light airplane. It could be readily carried on the broad, flat afterdeck of the boat, its wings folded but ready for quick take-off for a wide patrol range or bombing. With an engine of from 90 to 100 hp. it could carry enough fuel for six hours of flying at patrol speed, with two 50-lb. bombs under the wings. In four hours such an airplane could cover a circumference of about 260 miles on about 25 gallons of gasoline, compared with the 600 gallons required for the PT boat to cover the same area under its own power and, having ample elevation, it could spot a submarine and either drop bombs on it or lead the PT boat to the location for the finishing blow.

Manned by Civil Air Patrol pilots, many of whom are ready and eager for service, 30 of such aircraft could patrol the 2,500 miles of coastline from Maine to Miami and proportionate numbers could patrol the West Coast, the Gulf Coast and the Caribbean. The total cost for light airplanes for the Atlantic Coast patrol is estimated by this writer at about $80,000, a small fraction of the value of a single ship that might be saved from sinking, and the cost of operation would be negligible by comparison with the enhanced service rendered by the PT boat. *Aero Digest*, May, 1942, page 62, 2 illus.

El Empleo de Unidades Aereas contra Elementos Navales de Superficie y Submarinos (The Use of Aerial Units Against Surface Vessels and Submarines). Vicente Ruiz. Events transpiring in this war which have a bearing on the widely debated question of the relative merits of naval surface ships and aircraft are reviewed. Those events have convinced many who were still doubtful that even the most modern battleship may fall victim to aircraft. Reference is made to the construction and armament of modern warships and to the penetrative power of aerial bombs. A special chapter treats the aerial torpedo, and attacks by torpedo airplanes on ships at anchor and at sea. With reference to aircraft carriers that are having their first opportunity to play an important part in modern combat, the writer believes that changes are needed in their design to overcome the vulnerable features that he believes have been demonstrated. The use of aircraft in the detection and destruction of submarines is also discussed. *Avia*, January, 1942, pages 13–17.

Aircraft Carriers in the Pacific War Arena. Gordon A. Reeves. An attempt to assess the relative carrier strength of the United States and Japan synthesizes descriptions, displacements and capacities of present carriers on both sides, as well as giving an outline of the probable American expansion program. *Canadian Aviation*, April, 1942, pages 24–27, 3 illus.

Personalities

Silhouettes. Short biographies of Guy P. Gannett, Publisher and Maine Wing Commander of the C.A.P. and of H. T. Cole, President of the Sportsman Pilots Association, pay tribute to their interest in aviation and contributions to its advancement. *The Sportsman Pilot*, April 15, 1942, pages 34, 36, 4 illus.

Personnel

American Aircraft & Engine Manufacturers. A directory of the executive, engineering and production personnel of the leading airplane and engine manufacturers of the United States. A list of the names and addresses of the propeller manufacturers is also included. *Western Flying*, April, 1942, pages 42–47.

Encouraging Employee Thinking. Russell Newcomb. This article presents the operation and results of a suggestion campaign conducted by the RCA Manufacturing Company and the system for submitting, protecting and considering ideas which has resulted in a steady stream of employee suggestions. *Aviation*, May, 1942, pages 74, 75, 243, 1 illus.

Plants

Underground Factory. A description of the equipment and operation of aircraft plants that have been built in the galleries of old chalk mines and quarries in England in order to protect them from air attack. These new locations not only utilize existing excavations, some of which date back to the Roman occupation, but have prompted newer and deeper burrowing below surface. The article suggests that, in case of emergency, such natural shelters as the Mammoth Cave in Kentucky and the Carlsbad Caverns in New Mexico could be used in a similar manner. *Aviation*, May, 1942, pages 76, 247, 4 illus.

Innovations in Airplane Plant Design. M. M. Valentine. An architect's view of the problems involved in the efficient design of aircraft plants built with a view to meeting the immediate job of producing large quantities of aircraft at present and still have maximum value for postwar manufacture. The main design considerations dictated by current and future conditions are outlined, and some of the features that are incorporated to meet these needs, such as column-free floor space, proper air-conditioning and lighting are explained. *Aviation*, May, 1942, pages 96, 97, 248, 3 illus.

Plastics

Working Transparent Plastics. John Sasso. The first of a series on the general characteristics, forming and joining of acrylic plastics for aircraft installations. This installment presents the procedure in heating the plastic sheet, designing and constructing the forms, stretching, cementing, joining and taping the transparencies and applying jigs for cementing special jobs. *Aviation*, May, 1942, pages 86, 87, 89, 93, 95, 7 illus.

Moulded Aircraft Units. A survey of the development of resin-bonded plywood for aircraft construction analyzes the possibilities of its use. Although it is stated that advanced development work is being carried on in England, most of the examples refer to airplanes produced in the United States. Among the processes outlined are the Merron Moulding Processes, Vidal Process, Duramold Process and Aeromold Process. *Aircraft Production*, April, 1942, pages 312–315, 10 illus.

"Wooden Wedding." John Harwood-Jones. A consideration of plywood airplanes and the plastic adhesives that make them functional, with particular attention to the plywood nose of the Avro-Anson bomber. Details on how this is constructed provide a working example of plywood construction in aircraft. *Canadian Air Cadet*, April, 1942, pages 19, 26, 27, 30, 3 illus.

Production

Politicians Don't Build Planes. Cy Caldwell. This defense of American aircraft manufacturers points out that, in spite of the criticism to which they have been subjected, they have accomplished almost unbelievably amazing objectives and that the production record they have established under manifold handicaps is unequalled by that of any other industry. The writer relegates the blame for bottlenecks to other sources and claims that the chances are 100 to 1 that the bottleneck is not in the airplane factory but in one of the thousands of other factories making essential parts and equipment. Admitting that there are many errors of omission in earlier planning still to be corrected, he alleges that we are getting a much higher return than our lack of planning deserves. *Flying and Popular Aviation*, June, 1942, pages 43, 106, 108, 1 illus.

You Can Manufacture Aircraft. Walter H. Wheeler, Jr. An outline of how small manufacturers have been incorporated into the aircraft production program surveys the seemingly unrelated kinds of factories that have been converted into war production plants and advises how this example can be followed. Describing the ingenuity and effort that must be applied to conversion of machinery, operation and personnel, it lists the names of governmental agencies that can give information and assistance. A table of regional offices where manufacturers may apply for contract advice is included. *Flying and Popular Aviation*, May, 1942, pages 22–24, 58, 61, 4 illus.

Bomber Engines by Buick. Ability of American industry to overcome war problems as exemplified by the record of the Buick Division of General Motors in attaining production of Pratt & Whitney-type aircraft engines a full nine months ahead of schedule is related in this article. How the plant was retooled, employees trained and required, War Department tests cut down to two weeks instead of four or six weeks is narrated, and some of the operations are illustrated. *Aero Digest*, May, 1942, pages 105, 106, 11 illus.

Controlling Physical Properties of Rivets. John H. Eades. This article examines the special technique developed by the Glenn L. Martin Company for the mass handling of treated aluminum alloy rivets. The system for handling the correct amount of rivets, the treatment they undergo and the special facilities for their cold storage until they are ready for use are described. *Aero Digest*, May, 1942, pages 179, 180, 183, 7 illus.

New Type Rivets End Blind Riveting. J. J. Russell. Description of a newly developed tubular-type rivet designed to eliminate the problem of "blind fastening." The structure and application of the new fastener, its design considerations and the tools required for its installation are explained. *Aero Digest*, May, 1942, pages 239, 240, 6 illus.

Australia's Aircraft Industry Helping RAAF Expansion. A report on the development of aircraft production and production facilities in Australia, chiefly built within the shadow of imminent invasion under the direction of Wing Commander Lawrence J. Wackett. The article indicates how existing facilities for railroad maintenance were adopted and factories were created from scratch for the building of the North American NA-33, the Beaufort and the light Wirraway trainer, which were redesigned to adapt them to the peculiar local production conditions. *Aero Digest*, May, 1942, pages 82–87, 7 illus.

Investigations of Labor Time Losses. Stating that the greatest number of labor-hours does not necessarily yield maximum war production, this report reveals the results of research into causes of absenteeism and the palliatives applied in the British war industry. Overlong hours at sustained stretches, psychologic factors, bombings, wartime transportation difficulties, and special problems affecting female personnel are credited with the majority of lost labor-hours. Methods of alleviating these conditions are outlined with education and stimulation of incentive within the factories particularly stressed. However, it is averred that the only way to eliminate the problem lies in reducing the number of working hours so that they do not exceed 60 per week for each person, and in order to do this a three-shift system must be instituted. Conscripting all their labor resources, the British have attained this goal, with the result that absenteeism and lessening of efficiency are stated to be major problems no longer. *Aero Digest*, May, 1942, pages 136, 355, 356, 1 illus.

Refrigeration for Assembly. A survey of the uses of various types of low temperature equipment as applied to the manufacture and production of aircraft engines and instruments. The described shrinking refrigerators for general and specific purposes are those built by the Pressed Steel Co., Ltd. *Aircraft Production*, April, 1942, pages 275, 276, 3 illus.

Douglas Line Assembly. British interpretation of a line-assembly system for accelerating production of Boston nose sections in use at the El Segundo plant of the Douglas Aircraft Co. Its similarity of principle is identified with that of the fuselage assembly adopted for the Blackburn Botha and is said to be capable of extension to many other aircraft units. *Aircraft Production*, April, 1942, page 297, 1 illus.

Tube Bending. Explanation of a method of setting tubes by the use of sliding mandrels. The advantages claimed for it are simplicity, economy, ability to be manipulated by unskilled labor, and the fact that it can be performed in one-twentieth of the time required by the conventional method of tube bending. *Aircraft Production*, April, 1942, page 310, 1 illus.

This Priority Business. An explanation of the now simplified procedure for obtaining and putting into effect priority ratings in the United

Built by the Langley Aircraft Corporation of New York, this 4-place twin-engined "Langley" plane uses Catabond #590 for all integral structural members and wherever motor heat might directly affect the bond.

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In the autoclave processes, the development of Catabond #590 is of special significance. Previous phenolic resin formulae required curing in temperatures above 230°F., causing the rubber bags used in these processes to deteriorate quickly. Because of the new, low temperatures employed, their life can now be extended greatly.

However, other possibilities are now open. Large, easily constructed insulated rooms maintained at 140°F. and in which humidity could be readily controlled to maintain wood stability, offer distinct advantages for curing plane assemblies glued with Catabond #590. Mixing, handling, spreading and clamping properties are almost identical with those of casein glue.

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Glue lines with this resin are stronger than the wood itself . . . shear tests on 3 sq. inch blocks Birch to Birch, have averaged 2772 lbs. per sq. in. parallel to the grain and 1059 lbs. per sq. in. perpendicular to the grain. Other tests in which alternating cycles of 8 hrs. in boiling water, 8 hrs. in cold water and 8 hrs. of drying for 8 days were conducted. The specimens were manually destroyed and no evidence of joint failure could be found. 4 ft. panels of typical wing construction were immersed in a tank of boiling water for a day, then oven-baked to develop violent shrinkage stresses. Catabond successfully resisted the stresses. Test panels were exposed for a year, moored to a roof, without any ill effects . . . panels with other glues, similarly tested, collapsed shortly after being exposed.

"Catabond" hot, intermediate and cold-setting liquid phenolic resin formulations are employed in glueing, bonding, impregnating, compregnating and molding wood, plywood, abrasives, sisal, cork, canvas, fibre, etc. New adaptations are constantly being developed by Catalin engineers and chemists to meet the individual requirements of industries and manufacturers. Your inquiry is invited!

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States for Canadian war contractors and subcontractors. Advice is given on what preference rating certificates are required for different classifications of material and work, how to obtain the certificates, and how to comply with the regulations for filling them out. A comparison is also made between the formal priority rating system of the United States and the one used by Canada which is claimed to be more flexible. *Canadian Aviation*, April, 1942, pages 88, 89, 2 illus.

Propellers

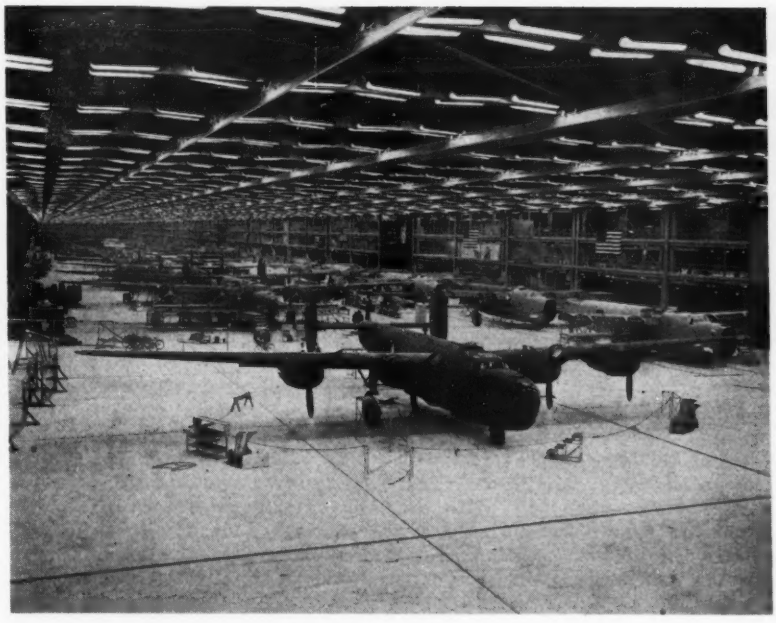
Dynamic Balancing of Propellers. E. Kronauer. Description of the plant operated by the Escher Wyss Engineering Works of Zurich, Switzerland, for the dynamic balancing of propellers, giving particular attention to the theory and operation of an optical oscillograph that permits the direct indication of angular position of unbalance, measures oscillations not perceptible by means of the value system and permits the determination of irregular disturbances caused by aperiodic and constant changes in course of oscillations. *Aviation*, May, 1942, pages 119, 121, 244, 5 illus.

Jablo Airscrew Blades. Dealing with the manufacture of Jablo blades by F. Hills and Sons, Ltd., this is a twofold account: first, about how the built-up block from which the blade is machined is derived from logs; second, about the machining, balancing and surface-finishing of the blade. From log to finished component considered in detail are: the preliminary stages, assembling the boards, trimming, block assembly, history system, machining, threading and the finishing processes. *Aircraft Production*, April, 1942, pages 277–282, 15 illus.

The Hoover Propeller. With particular emphasis on design and operation, this description of the Hoover Hydraulic Propeller is devoted to the hub construction and operation of the constant-speed propeller, two-position hydraulic propeller, and the constant-speed full-feathering hydraulic propeller types. *Canadian Aviation*, April, 1942, pages 28–30, 5 illus.

Radio

Airways Radio Standardization. David S. Little. The second in a series on the standardization of airliner radio equipment through the agency of Aeronautical Radio, Inc., the airline agency for the coordination of engineering and procurement of transport radio equipment, this installment outlines the standardization and adaptation of various types of ultrahigh frequency equipment, including that which is needed for complete instrument landings, two-way voice units and special radio range receivers. *Aero Digest*, May, 1942, pages 99, 100, 267, 269, 270, 3 illus.



Consolidated's long range B-24 land bombers on the mechanized assembly line of the corporation's new plant in the southwest.

Pitfalls of Radio Orientation. Ray B. Morse. A study of the shortcomings and inaccuracies of various systems of instrument approach, indicating the manner and conditions under which these idiosyncrasies develop and the steps that can be taken in recognizing and circumventing them. *Aero Digest*, May, 1942, pages 115, 116, 269, 270, 4 illus.

Rotating Wing Aircraft

The Design of Rotor Blades. R. H. Prewitt. The factors that affect the design of flexibly mounted rotor blades—that is, blades incorporating horizontal and vertical hinges—are practically the same for autorotating rotors and power-driven rotors in so far as knowledge of power-driven rotors has progressed to date.

The design of rotor blades may be divided into two parts: (a) determination of the physical dimensions and (b) detail design involving airfoil characteristics, including moment coefficient, chordwise center of gravity, blade weight, external smoothness, blade twist, thickness ratio, and internal structure. The two factors to be considered in determining the physical dimensions of the blades are blade loading and solidity (ratio of the blade area to disc area). The rotational tip speed varies as the square root of the blade loading; thus blade loading provides a convenient means for causing the maximum L/D to occur at a given forward speed. With the same blade loading and all other factors equal, the maximum L/D of a rotor increases with decreased solidity.

This paper takes up the general aerodynamic and design considerations, discusses the distribution of air and centrifugal loads and bending moment relief, and closes with a consideration of torsional moments and of various types of construction. *Journal of the Aeronautical Sciences*, May, 1942, pages 255–260, 13 illus.

Helicoptere voor Troepentransport (The Helicopter as a Troop Transport). There are rumors that Germany is experimenting with the Focke-Wulf helicopter as a medium for troop transportation. The evasive language of Professor Focke's patent papers strengthens the belief that Germany had the idea of making use of this craft for military purposes at the time the patent was granted in 1938.

The Focke-Wulf design shows two counterrotating rotors, each of which is mounted on a separate fuselage and has a separate power source. At the fore parts the fuselages are connected to one another by means of a carrying surface and by a horizontal tail surface at the rear parts. There is no elevator. The aircraft is controlled by the variation of the angles of incidence of the rotors. Each

fuselage is equipped with a single-wheel retractable landing gear. A tail wheel is attached to the tail surface.

According to the patent papers the rotors are synchronized by means of either electrical, hydraulic or mechanical operation. It is also said that there are plans under way to convert this helicopter into a seaplane by equipping it with floats. Its stability characteristics and its vertical take-off do not require these floats to be of special or even of conventional design. *Vliegwereld*, January 22, 1942, page 788, 1 illus.

Stress Analysis

Stress Analysis of Rings for Monocoque Fuselages. N. J. Hoff. Suggestions are made for reducing the work and for increasing the accuracy of the calculation of the unknown quantities in closed rings of arbitrary shape for monocoque fuselages. The advantages of assuming three or four imaginary pin-joints instead of an imaginary cut through the ring are shown. Graphic methods are introduced for the determination of the moment distribution in the "simple" system caused by the shear flow transmitted by the sheet covering. Worked out examples show the application of the principles to numerical problems. *Journal of the Aeronautical Sciences*, May, 1942, pages 245–251, 12 illus.

On an Extension of Reynolds' Method of Finding Apparent Stress and the Nature of Turbulence. P. Y. Chou. The important part of this paper deals with the derivation of, besides Reynolds' equation of mean motion, a set of equations of turbulent fluctuation and its solution. The latter set necessarily follows if the former is subtracted from the original Navier-Stokes' differential equations. To solve these equations of turbulence, velocity and velocity, and velocity and pressure correlations of the second and third order and the differential equations satisfied by them are built. It is shown that these equations containing correlations have no definite solution unless two new hypotheses are introduced; one is merely a mathematical approximation in nature and the second can be interpreted physically to show that turbulence is the sum of two parts. One depends upon the mean pressure gradient in the moving fluid while the other does not. The general theory is then applied to explain the pressure flow between two parallel planes. The result is in good agreement with observation. *Chinese Journal of Physics*, June, 1940, pages 1–33, 3 illus.

Analysis of Shear Stresses in Aircraft Shells. J. Meyer. The skins of relatively thin shells stiffened by longitudinals serve two prime purposes in aircraft construction: (1) They distribute among the longitudinals the axial load due to bending; (2) they resist torsion. Both these cases entail shear.

The writer presents a mathematical formula analyzing shear stresses and applying the membrane analogy as developed by Prandtl. *Aero Digest*, May, 1942, pages 170, 171, 175, 176, 274, 275, 16 illus.

Strength Analysis of Riveted and Bolted Joints. Wayne A. McGowan. The concluding installment of a series on methods for calculating riveted and bolted joints. *Aviation*, May, 1942, pages 105, 107, 109, 111, 112, 14 illus.

Design Charts for Tubes Subjected to Torsion. Walter C. Clayton. This second installment in a series on design charts for tubes subjected to bending describes the method for creating and applying charts for determining the safe wall thickness for tubes subjected to torsional shear. *Aviation*, May, 1942, pages 127, 129, 131, 4 illus.

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Properties	Synthetic Ameripol	Natural Rubber	Properties	Synthetic Ameripol	Natural Rubber
Resistance to:			*Range of:*		
Abrasion	★		Elasticity		★★
Acids and Alkalies	★		Elongation	★	
Aging	★★		Hardness	★	
Heat	★★		Permanent Set	★	
Oil, Grease & Petroleum Solvents	★★		Tensile Strength	★	
Oxidation	★★		*Reaction to:*		
Tear		★★	Sub-Freezing Temperatures		★★

Code: ★ Equals ★★ Excels

Ameripol, a product of 16 years' research in B. F. Goodrich laboratories, was first announced publicly in June, 1940, as a practical substitute for natural rubber in tires. On the right-hand page are some of the products made with Ameripol that are now *in the air!* We are proud of this contribution and we pledge our continued efforts to "Keep 'em Flying" with natural and synthetic rubber parts.

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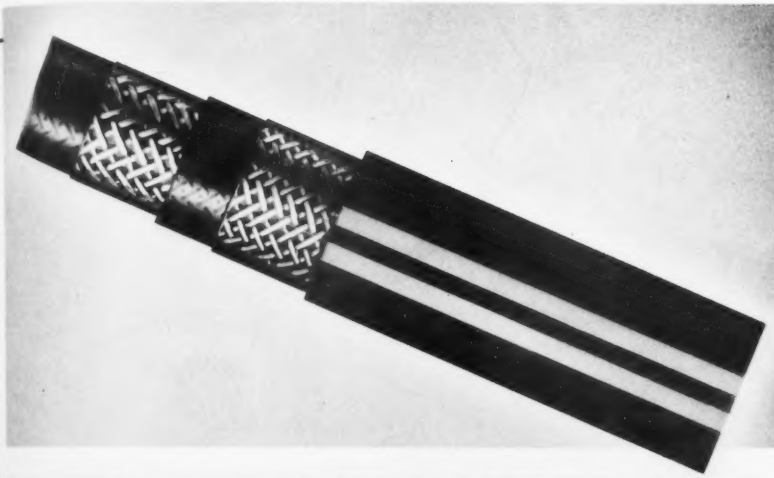
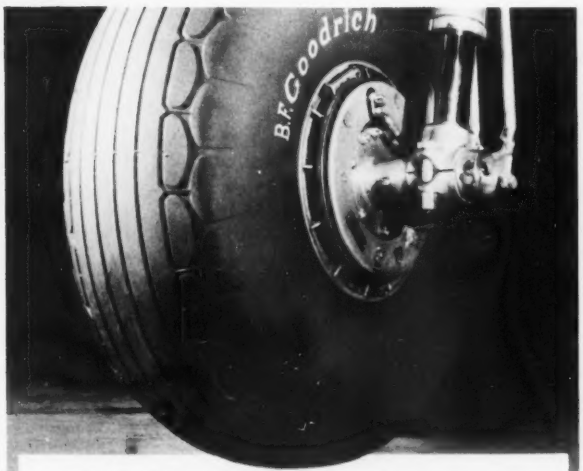


GASOLINE AND OIL HOSE. Airplane hose serves in a number of important products on United States fighting planes. Proved by performance, Ameripol synthetic rubber was used for B. F. Goodrich fuel and oil hose many months before the war emergency brought synthetics to their present prominence.

GROMMETS ★ HYDRAULIC SEALS ★ GASKETS. Perhaps they look trivial. But they're vital to a plane's performance. Made with Ameripol, they offer: low oil absorption (swell does not exceed 6%)—high resistance to wear, heat and sub-zero temperatures—will not corrode metals—can be accurately molded to desired precision tolerances.



THE EXPANDER TUBE of a B. F. Goodrich E. T. Brake is also made of Ameripol. When this tube is inflated with braking fluid, it expands, forcing the brake lining blocks into uniform contact with the revolving brake drum attached to the plane wheels, and the plane comes to a smooth, safe stop.

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to the B. F. Goodrich products indicated on this plane design. There are more than 50 in use today on planes ranging from primary trainers to front-line pursuits and huge 4-motored bombers. That's why the aviation industry has, for years, looked to B.F. Goodrich as "First in Rubber."

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Superchargers

Supersonic Flow in Turbines and Compressors. K. W. Sorg. A translation from *Luftfahrtforschung* for November-December, 1939, deals with questions relating to the flow at supersonic velocities through centrifugal machines, seeking to determine the conditions for the existence of a minimum cross section and the occurrence of compression shocks in turbine rotors. Equations are derived showing that both for infrasonic and ultrasonic (supersonic) velocities an extremum of the cross section is possible, applying equally to a cross section normal to the lines of relative flow and normal to the lines of absolute flow.

These general equations are applied to special cases involving different forms of rotors and blades, leading to the result (limited to the usual forms of rotors and blades used in centrifugal machinery) that a minimum cross section is found for radial steam turbines and axial rotors. A maximum of the cross section perpendicular to the relative flow is found in radial rotors which have considerable radial differences, such as turbocompressor rotors.

The occurrence of compression shocks in centrifugal rotors is next investigated, it being found that the same conditions are applicable and that compression shocks can occur at any value of the ratio of absolute velocity to the velocity of sound. Sonic velocity in a gas flow absorbing or emitting energy is defined within the sphere of influence of the rotor, and a lower limit is obtained for the occurrence of compression shocks, which result is reconciled with the general laws relating to gases, in the absence of a change of state due to exchange of energy with the surrounding medium, as in the case of discharge nozzles. It is attempted, with the aid of the results obtained, to define some of the requirements for the design of centrifugal machines to operate at supersonic velocities, with a view toward the avoidance or diminution of wave formation and compression shocks. *Journal of the Royal Aeronautical Society*, March, 1942, pages 64–85, 21 illus.

Superchargers and Exhaust Turbine Superchargers. J. L. Beilschmidt. A review of some of the basic supercharger design principles, this article reviews the primary physics involved and their application to the conditions requiring engine supercharging. This is followed by an examination of the various types of superchargers already in existence, including the multistage and exhaust-driven designs. *Aeronautics*, April, 1942, pages 50–60, 12 illus.

The Boeing B-17E, newest in the Boeing flying fortress series.

Testing Equipment

Allison Testing Facilities. By means of pictures and captions the equipment used in testing Allison aircraft engines is presented. *Automotive and Aviation Industries*, May 1, 1942, pages 38, 39, 6 illus.

X-Ray Examination of Castings. Description of the technique developed by the Aircraft X-Ray Laboratories to examine cast parts by x-ray analysis. It is demonstrated that the correlation of this radiographic diagnosis with factory procedure contributes to the improvement of casting quality. *Aero Digest*, May, 1942, pages 209, 357, 6 illus.

Tools

Diamond Tools. Part II. Paul Grodzinski. Discussion of the use of diamond tools for final machining operations and descriptions of some of the most recent types of holding fixtures comprises this second and final installment. Diagrams illustrate the explanations of the mechanics of fixed and adjustable boring tools, special lathe tool holders, milling cutters, speeds and feeds. The problems of maintenance and care are also covered. *Aircraft Production*, April, 1942, pages 318–322, 15 illus.

Tools and Equipment

The Aero Storekeeper, With His 108,000 Items—Keeps 'Em Flying. Resembling a gigantic hardware store, the Supply Section at Patterson Field's air depot carries in stock no less than 108,000 different parts and fittings ranging from a complete airplane wing or engine down to small pieces of metal tubing and including flying suits and emergency kits for jungle landings. The system devised for storing these materials in such a way as to be readily accessible to answer urgent calls from other fields is explained and the use of some of the odd equipment kept on hand is shown. *Popular Science*, June, 1942, pages 58–61, 13 illus.

Drop-Hammer Methods in Aircraft Production. C. J. Frey and Stanley S. Kogut. The beginning of a series on the drop hammer and its application in aircraft production. This installment traces the history of the drop hammer back to da Vinci and Brett, locates its introduction to airplane building in the United States at the Prudden Aircraft Company in 1928, and indicates the tool's versatility for the forming of nonferrous sheet parts. The types of hammers used, special considerations for their design and their development and increased application as well as foundation, die and furnace considerations are also presented. *Aero Digest*, May, 1942, pages 199–204, 272, 10 illus.

Hydraulic Dynamometers for Aircraft Engine Testing. E. L. Cline. A description of the Clayton dynamometer for testing aircraft power plants. According to the writer, this type dynamometer, which applies the

principle of maintaining a constant volume of water in the absorption unit, provides accurate measurement, flexibility and decreased noise in a smaller cell than some other types of similar purpose equipment. *Aero Digest*, May, 1942, pages 245, 246, 266, 4 illus.

Training

London Journey. John Paul Riddle. An account of a visit to the training centers of England gives the reasons for the writer's belief that the entire air training program must be accelerated. The suggestion that England's example be followed by starting boys with fundamental training in aviation at the age of 16 is supplemented by the conclusion that the vast aviation program goes beyond the borders of the Army and Navy and can only be effected with full civilian cooperation. *Flying and Popular Aviation*, June, 1942, pages 34, 104, 1 illus.

The Negro as a Military Airman. Frank Lambert. This analysis of the Negro's aptitude for piloting asks for an equality of consideration for these men based on the elimination of both special privileges and special prejudices. Strongly adjured is the judgment of each man on his specific merits rather than as a member of a race, just as is the case with white fliers. Experience with the first class of Negro military aviators at Tuskegee, Ala., is outlined in detail to bear out the point that these men as a group have no special talents or deficiencies, but as individuals some have the abilities to make fine pilots and others have not. It is also demonstrated that preconceived notions about these fliers are unfair because it puts the men under terrific strain to feel that they are the subjects of an experiment rather than just aviation trainees, thus impairing their usefulness to the war effort. *Flying and Popular Aviation*, June, 1942, pages 33, 34, 66, 68, 70, 1 illus.

If You Are a Drafted Pilot. F. R. Wyatt. Subject to the comment that every case is individually considered, this is a statement of the status of the private pilot under the Selective Service System. Although the System makes no provision for private pilots as a class, it is suggested that once in the Army they make application for air cadet training where any special abilities they may have will be welcomed by the Air Forces. With the observation that not every private flier makes a combat pilot, the writer reviews other flying jobs for which a man may be qualified by experience gained in civil piloting. *Flying and Popular Aviation*, May, 1942, pages 25, 94, 95, 1 illus.

They Call It Thunderbird Field. Gerrie Griffith and Clarence Lincoln Block. A description of the new Air Corps Training School now graduating 2,000 Army pilots a year. How the school was founded, the men who run it, the physical layout of the colorful buildings and field, and financial details of its upkeep are all given in detail. A portion of the article concentrates on the Chinese students who receive instruction along with American students There is also a brief account of the English students who are being trained at Falcon Field, a nearby school also sponsored by the same group. *Saturday Evening Post*, May 2, 1942, pages 19, 49, 50, 4 illus.

Starlight, Star Bright. K. S. Lester. An aviation cadet relates his experiences in a squadron night flight . . . . how he goes up, what he does, and what his reactions are. *Air Facts*, May, 1942, pages 18–21.

The Army Aviation Training Program. Major Nathaniel F. Silsbee. Expressing confidence that the announced goal of 60,000 airplanes for the Army and Navy and 1,000,000 men for the Army Air Forces will be achieved this year, the Chief of the Research Section, Public Relations Branch of the Army Air Forces, reviews briefly the process of selecting and training aviation cadets. After the initial three weeks at the reception center prospective pilots, bombardiers and navigators undergo four periods of nine weeks each, the first at the replacement center, the second at the elementary school, the third at the basic school and the fourth at the advanced school. Bombardiers and navigators get additional periods of specialized training. The ground organization and the Air Force supply, maintenance, warehousing and air transport groups are also described. *Technical Education News*, April, 1942, pages 1, 8, 9, 3 illus.

The Navy Aviation Training Program. Rear Admiral J. H. Towers. A training program of gigantic proportions is visualized by the Chief of the Bureau of Aeronautics of the United States Navy to maintain the authorized naval air strength of 27,000 airplanes. The problem of shifting from a peacetime basis to a wartime basis of training has been one of adjustment, procurement and expansion. The Aviation Training Division handles all matters relating to pilot training and has projected a program contemplating the addition of 2,500 students each month. The first three months of training are spent at ground schools of which there are four, located at Universities in North Carolina, Georgia, Iowa and California. After a period spent at research centers, successful cadets are appointed as aviation cadets and sent to one of the 16 Naval Reserve Aviation Bases, where complete primary landplane courses are conducted. From the primary training bases, successful cadets progress to the intermediate and advanced training courses at Naval Air Stations where they are commissioned as ensigns and designated as naval aviators. Instead of the former long training period with the fleet, under the new system the pilot will join a squadron fully familiar with his aircraft. It is estimated that the program in full operation will include 22,500 student pilots at all times. The specialized training given in gunnery and bombing and for aircraft-carrier pilots is detailed. *Technical Education News*, April, 1942, pages 1, 3, 11, 3 illus.

Teaching American Technique. An interpretation of the function of the R.A.F. School of Technical Training at which courses are held to familiarize skilled British ground staffs with American airplanes, engines and equipment. With the increasing use of Twin Wasp and Cyclone engines in British airplanes the essential purpose of the school is to spread specialized knowledge throughout the R.A.F. squadrons equipped with United States airframes and engines. The story of the founding of the School of Technical Training, as well as the course of instruction it gives, is also explicated. *The Aeroplane*, April 3, 1942, pages 390, 391, 3 illus.

Fly or Die. Robert H. Hinckley. A study of the United States program for aeronautical education in the primary and secondary schools which is designed to surpass the widespread "air conditioning" to which the youth of Germany was exposed during the past decade. The article names those educators who have aided U.S. Commissioner of Education John S. Studebaker in laying out the plans for the program, records the results of the basic research recently completed on the subject and explains the teaching aids which are planned to spread aviation training into all of the primary, secondary and technical schools of the country. *National Aeronautics*, May, 1942, pages 16, 17, 3 illus.

Pilots and Professors. Charles I.

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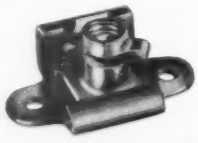

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Stanton. A study of the past performances of the Civilian Pilot Training Program and the manner in which the project developed pilots and instructors for the nation's war effort. The article also includes a capsule form requirement sheet for C.A.A. training requirements. *National Aeronautics*, May, 1942, pages 12, 29, 2 illus.

Airman's Canada. Michael Gray. A short commentary by an English pilot-in-training on the finishing of his course in Canada. Touching upon the additions to instruction, working schedule and examinations, it is concerned mostly with his reactions to the Dominion and the splendid hospitality he was accorded there. *The Aeroplane*, March 27, 1942, pages 354, 355, 3 illus.

The British Commonwealth Air Training Plan. An examination of the history and progress of the British Commonwealth Air Training Plan which began in Canada with the 4,500 R.C.A.F. pilots and mechanics in 1939 and has grown to over 100,000 at home and overseas. The article relates how the plan was conceived and how its execution began and shows how far it has progressed toward its ultimate goal of providing the man power needed to achieve final victory in the air. *Aero Digest*, May, 1942, pages 76, 79, 80, 11 illus.

Education for the Air Age. New responsibilities for teachers and school administrators are set forth in an outline of the duties of preparing the children and youths of this generation for the "air age" in which they will live. The importance of education for the aeronautical environment of the future is stressed, in view of the fact that the air element opens vast new horizons for the general public and greatly lessens distances. Mention is made of the use of cargo aircraft and the probability that residential areas will be expanded to an extent far greater than was accomplished by the automobile. Decentralization of cities is likely to be carried to a much greater degree, for military, industrial and commercial considerations. Education for these new conditions and training for the actual manufacture and operation of aircraft are regarded as essential. *Aero Digest*, May, 1942, pages 70, 256.

Turning Out Instrument Pilots. Henry W. Roberts. A description of the training, equipment and special operational problems involved in the instruction of Pan American Airways flight personnel for routine transoceanic operation. *Aviation*, May, 1942, pages 196, 197, 243, 4 illus.

Empire Air Training. Successful completion of the first year of operation of the British Commonwealth Joint Air Training Plan is reviewed and the opinion is expressed that the results achieved have outstripped the original estimates. How an adequate supply of training aircraft was maintained and how the output rate of pilots, observers, air gunners and wireless operators increased greatly are shown. The Commonwealth Scheme in Canada provides complete training up to the operational stage for these ratings, the majority of cadets being drawn from the Dominion, although others have been provided at the agreed proportions from Britain, Australia, New Zealand and Newfoundland. The plan administers 124 training establishments of all kinds which have been built up from the nucleus of the 22 flying clubs of Canada, to which were added several schools operated by the air transport companies, this civilian aid having proved valuable. The advantages of Canada as a training center are mentioned, but it is noted that the work is also carried out in other parts of the Commonwealth and cadets come from every section of the British Empire and other nations. *Flight*, April 2, 1942, pages 308–310, 5 illus.

Fly for Your Lives. Robert H. Hinckley. Revelation of how German children are inoculated with air-mindedness in every phase of their early education is the basis of a plea for the United States to profit by their example. Story-telling begins with Icarus; elementary arithmetic examples are about airplanes instead of apples or horses or any of the other standbys; higher mathematics problems concern navigation and meteorology. Basic nouns and verbs are of the "flight" and "glide" variety; chemistry studies stress the problems of supporting gases for lighter-than-air craft, deicing, and aluminum alloys; physics courses are dominated by a thorough study of flight principles; biology specializes in the physiologic effects of flying on the human body; even such unrelated subjects as art are permeated with examples of flying.

Without advocating this disproportionate forcing of aviation upon our educational system, this article points out that there are many ways in which the system can, and should be, supplemented to keep pace with a dynamic society in which "air-conditioning" is now a vital necessity. *Colliers*, April 25, 1942, pages 14, 15, 61, 5 illus.

The Army's Advance Observation School. A report on the Advanced Observation Flying School at Brooks Field, Texas, describes how officers from all branches of the service—Infantry, Cavalry, Artillery—are trained by the Air Corps to become the "eyes" of the Army . . . . the observer half of observer-pilot teams who fly over enemy territory to seek out in advance important military information. Courses include training in navigation, communications, mapping and aerial photography, as well as a refresher course in military tactics of all branches of the service and a review of the latest strategy of modern warfare. *The Sportsman Pilot*, April 15, 1942, pages 30, 38, 3 illus.

Flying as It Was . . . . . The First Days of Kelly Field. Major Nathaniel F. Silsbee and Captain James T. Sheridan. Tracing the history of Kelly Field from its commencement prior to the first World War, this article reveals the part it has played in the training of heroic aviators for two wars, the men who have been affiliated with its development, and the metamorphic stages it has undergone. It depicts how, although the curriculum has changed many times at Kelly Field since 1917, the same standards of proficiency have been maintained. Continuing its tradition as the oldest advanced flying school in the United States, Kelly Field is now an important link in the advanced twin-engine training program for bomber pilots. The historic field also has a navigation school and is the Pilot Replacement Center for the Gulf Coast Air Corps Training Center. *The Sportsman Pilot*, April 15, 1942, pages 14, 15, 36, 5 illus.

Norwegian Exodus. Elizabeth Trott. A statement of the removal of the Royal Norwegian Air Force's elementary training school to northern Toronto includes an outline of the plans which have been laid for this new extension and the objectives that are expected to be accomplished there. Speculation is made as to the reasons for the move and mention given to the fact that the Fairchild trainer is being used for the instruction of the young Norwegian flyers. *Commercial Aviation*, April, 1942, pages 36, 38, 40, 14 illus.

Warfare

Where Is Our Air Power? Colonel Roland Birnn. This is an attempt to supply some of the answers to the questions about how our air power is being distributed and where the airplanes coming off our assembly lines are going. With demand for American aircraft at so many points of the earth just now, it is pointed out that American air power must of necessity

be spread thinly for a while. A large part of it can be accounted for in control of the Atlantic . . . . patrolling the skies from Iceland to the Panama Canal and South America, over defense bases at Newfoundland, Bermuda and Puerto Rico, and various islands in the West Indies. The British Isles, India, Australia and the Southwest Pacific, Iceland and Alaska are other places mentioned as having requisitioned their share of American aircraft. This article also names specific planes, both bombers and fighters, which have proved their worth in battle. *Flying and Popular Aviation*, May, 1942, pages 31, 32, 61, 3 illus.

Civilian Defense Against Gas. Colonel Alden H. Waitt. Asserting that there is a definite possibility of attack on American towns with gas as an auxiliary to high explosives, this discussion outlines recommended measures to combat such attack. It considers in detail organization of the passive civilian population, as well as active degassing and emergency units, equipment for preventing and fighting the gas, special chemically treated clothing to be worn, protective ointments, shelters, special attention to public utilities and other precautions. Through organization, education and training, it is stated, the people can find the practical means of reducing gas casualities to a minimum and the disorganization, demoralization and delay, which are the enemy's chief objectives for the use of this agent, will be almost entirely eliminated. *Flying and Popular Aviation*, June, 1942, pages 40–42, 62, 64, 3 illus.

XIF-1. Leighton Collins. Based on the premise that air power alone cannot win the war but that the airplane's greatest effectiveness is in support of naval or land units, this is a running commentary maintaining that to fully exploit military air strength the possibilities of the light airplane must not be overlooked. It is asserted that the military development of the small airplane must not be neglected because it presents a factor for training, observation and liaison work, ambulance and convoy duty, trailer planes and, most important of all, a potential assault weapon in conjunction with land troops. An explanation of these potentialities is given and, while it is stated that they are open to argument, the plea is made that they should be investigated, experimented with, and forged into weapons of use. *Air Facts*, May, 1942, pages 5–17, 6 illus.

1939: "The Royal Air Force Spans the Empire"—1941–1942: Imminent Reorganization of the Royal Air Force? Reviewing at considerable length the general strategy and policies governing the British efforts since the beginning of the war, the failures and successes on numerous fronts are examined with particular reference to the participation of the Royal Air Force. Arguments are presented for and against the independent operation of the air force as compared with separate air arms for the Army and the Navy and the advantages of a unified high command. Comparisons are made with the system used by the Germans in land operations as well as air operations. Opinions of numerous British military, naval and political leaders are quoted, and the article concludes with the statement that while the Royal Air Force could not span the Empire it saved the British Isles in the autumn of 1940. *Interavia*, Number 803–804, February 19, 1942, pages 1–10.

Panama Patrol. Walter Davenport. Limited, of course, by censor's restrictions, this is an account of a ride in a patrol bomber over the

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Panama Canal Zone and a report of how our defenses are manned and ready for the Japs to dare take a try at one of our main life lines. It offers a popular interpretation of the Panama Canal Zone military organization and personnel. Of significance is the related suspicion that the Japanese have a base or two in western South America. The internment of enemy aliens in that territory is also described. *Colliers*, May 16, 1942, pages 20, 40, 41, 43, 45, 2 illus.

The Air Staff-Car and Air-O-P. An allegation that the Royal Air Force should promote two other uses of the airplane—an air staff-car for the rapid transport of staff officers and an air observation post for short-range spotting of guns—is augmented by a survey of the type of craft that is needed. Required is an airplane that can take off from small fields and roads, which has a steep climbing angle and tricycle undercarriage that can be flown easily by pilots without intensive training and which is capable of carrying two persons and radio equipment. It must also have good all-round visibility, be easy to transport with wings folded, simple to maintain in the field, and must not interfere with present production program.

The article refutes possible objections on the ground of production, maintenance and vulnerability to air attack. It also presents a consideration for this purpose of airplanes that are already being manufactured. *The Aeroplane*, March 13, 1942, pages 293–295, 9 illus.

Coastal Convoy. Charles A. Parker. A proffered plan to protect our coastlines against the onslaught of submarines urges the utilization of bomb loads on commercial airplanes and an escort ship modelled after the old rum-running types for every coastwise freighter. This, it is stated, would mobilize forces—pilots, vessels, shipyards, and airplanes—which are not at present being utilized and would release facilities now tied up in convoy work which could be more effectively used elsewhere. *Yankee Pilot*, April, 1942, pages 11, 14.

Air Weapons. Major F. A. de V. Robertson. Drawing comparisons with the lessons of history in the cases of other new weapons, this article reviews the accomplishments and failures of aircraft in the present war. It is shown that there is a difference between superiority and mastery in the air, as demonstrated by numerous campaigns and battles. Services performed by the air arm in its three capacities as an adjunct to land forces, to sea forces and as an independent weapon are analyzed, and the functions of different types of aircraft are set forth. *Flight*, April 9, 1942, pages 345–348, 7 illus.

The Luftwaffe Threatens. H. J. A. Wilson. A study of the structure of the German Luftwaffe since its reorganization in February, 1939, indicating the division of its commands and its operation in Poland, Norway, France, the Low Countries, Britain, the Balkans, Russia and Africa. *Aeronautics*, April, 1942, pages 32–38, 6 illus.

Bombs Away! Lynn Farnol. An officer in the U.S. Army Air Corps relates the events in a typical routine patrol mission made by the Bomber Command over the Atlantic Ocean. Searching for enemy submarines, safeguarding our merchant ships, summoning aid for ships and seamen in distress, the successful accomplishment of the manifold operations of an airplane in the Bomber Command is dependent upon the perfect cooperation of its crew and their ability to "fly the ship, get there and hit something." *Collier's*, May 9, 1942, pages 19, 64, 5 illus.

Para-Ski Troops. A picture-aided outline of the course of training given U.S. parachute infantry in ski tactics. The course given teaches the troopers to assemble special equipment, pack it for parachute descent, perform their parachute descent, assemble in ski formation and fight under severe winter conditions. *Air News*, May, 1942, pages 12, 13, 11 illus.

Nazi Chutist. Pictures show the standard equipment of a German paratrooper, his clothing, arms, rations and identification. The equipment was taken from a captured paratrooper in Russia. *Air News*, May, 1942, page 20, 6 illus.

Welding

Stored Energy Welds Aluminum. C. E. Smith. Description of some of the latest developments in the field of resistance welding of high conductivity metals and alloys. These require a quick, intense fusion heat and subsequent cold working, which is accomplished by a process of storing the energy either electrostatically or electromagnetically and then discharging it in order to accomplish the task at a peak load lower than ordinary welders. *American Machinist*, April 30, 1942, pages 375–378, 5 illus.

Inspection of Arc Welded Work. Methods to be followed in the inspection of arc welding work are suggested in notes intended to assist in maintaining required standards in welding. The duties and functions of the welding supervisor are set forth, with instructions for securing the proper grades of welding machines and electrodes and for the preparation of the work.

Welding procedure is discussed under the headings of butt welds and fillet welds, with descriptions and illustrations of correct and incorrect workmanship. These examples, illustrated by sketches, indicate what the inspector should look for in detecting defective work. Heat-treatment and testing of the finished weld are covered. *The Engineer*, March 20, 1942, pages 254–256, 27 illus.

"Britain Calling." J. Bradbrooke. A symposium of current events in Britain reports that the people there, while speculating on the place of the enemy's expected Spring offensive, are urging that the United Nations initiate an offensive of their own. Details are given on several battles and air raids. Other features briefly discussed are torpedo bombers, engines and new types of aircraft including the Westland Whirlwind, underground aircraft production in Great Britain, and several types of German aircraft. *Commercial Aviation*, April, 1942, pages 42, 44, 46, 1 illus.

Wind Tunnels

Wright Field Speeds Plane Tests. Description of the newly-constructed wind-tunnel equipment at Wright Field and its application to the acceleration of airplane development. *Air News*, May, 1942, pages 26, 27, 6 illus.

Miscellaneous

Milady Is Building Airplanes. Robert H. Hinckley. Asserting that women are excelling in jobs requiring repetition, accuracy and patience, the Assistant Secretary of Commerce tells of the numbers and kinds of jobs they are assuming in airplane factories. In addition, he indicates that they are not limiting themselves to production work but have demonstrated their ability as instructors, inventors, airline employees and in other work. Willingness and eagerness to share the burdens of war are acknowledged as a contributing factor to their success. *Flying and Popular Aviation*, May, 1942, pages 28–30, 108, 109, 6 illus.

Veteran Air Pilots. The history and membership qualifications of the Veteran Air Pilots, an organization of fliers who have flown a minimum of 1,500 hours in ten years. The article introduces the founders of the organization, and some of the distinguished pilots who are members of the group. *Air News*, May, 1942, pages 28, 29, 13 illus.

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Government Publications

British Air Ministry

The following group of technical reports of the Aeronautical Research Committee of the British Air Ministry, not heretofore available, has recently been received from England. Therefore, although dated 1938 and 1939, they are reviewed in the following paragraphs as a contribution to current engineering data.

Flight Experiments on Boundary Layer Transition in Relation to Profile Drag. A. V. Stephens and J. A. G. Haslam. This paper continues the report on experiments on profile drag, begun in 1936, through exploration of the boundary layer in flight on wings whose drag had been measured. The purpose was also to examine the conditions under which transition occurs. The scope of the investigation included the determination of transition points by means of small-bore pitot tubes over a wide range of life coefficients on two smooth wings having maximum thickness of 10 per cent and 17.5 per cent, respectively. Determinations were made similarly behind the specified ridges on the wing surface. The several methods developed are described. The physical circumstances of transition were measured and grouped into nondimensional parameters.

It is concluded that (1) the full-scale determination of the transition point, which is of primary importance in considering profile drag and its possible reduction, can be made by a simple apparatus and methods suitable for use in the aircraft industry; (2) a spanwise ridge of 0.002 in. height on the wing surface was found sufficient to shift the transition point forward from 0.34 chord to 0.27 chord, at Reynolds Numbers of 5×10^6 and more; (3) disturbance caused by such a small ridge introduced into the boundary layer from the inside caused transition to shift forward but not all the way up to the ridge; (4) no basis for prediction of transition was found through analysis of the measured conditions under which transition occurred; (5) points in close agreement with the theoretic curves based on Pohlhausen's analysis were yielded by exploration of the boundary layer velocity profile. *R. & M., No. 1800*, price 7*s.* 6*d.*

An Investigation of Ground Effect With a Model of a Mid-Wing Monoplane. E. Ower, R. Warden and W. S. Brown. Measurements were taken of the lift, drag and pitching moment over a range of incidence on a four-engined, midwing monoplane model at varying distances from a plate representing the ground and also with the plate removed from the tunnel. Various flap, elevator and tail settings were tested, the results giving the changes of lift, drag and pitching moment with the approach to the ground plate. Deductions were made of the down-wash angles at the tail and of the tailplane and elevator efficiency. Observed effects are compared with the results shown in the theories of Hutchinson and of a Japanese report.

The conclusion is reached that the general ground effects are the same as those determined in previous investigations—that is, lift is increased at a given incidence below the stall and drag and pitch movement are reduced. A tendency toward an earlier stall is indicated, as well as a marked stabilizing effect on the slope of the pitching moment-incidence curve. The reduction in pitching moment due to ground effect progresses with incidence and becomes great at the landing attitude. The ground does not impair the efficiency of the elevators or the tail below the stall, there being an actual improvement in many cases as the ground is approached. No indication is found of the increase in maximum lift as reported in full-scale observations. Theoretic values of the down-wash are smaller than measured values, although substantial agreement is found between theory and experiment on total pitching moment with flaps neutral. Agreement with theory is also reasonably good in other respects, except with regard to pitching moment with flaps down and pitching moment with tail removed. *R. & M., No. 1847*, price 4*s.*

General Investigation Into the Characteristics of the C.30 Autogiro. P. A. Hufton, A. E. Woodward Nutt, F. J. Bigg and J. A. Beavan. This is a report on the performance of an autogiro, containing the first set of full-scale data to be obtained in Great Britain. Part 1 covers performance and aerodynamic characteristics. It consists of a description of the aircraft, particulars of the tests made, calculations and particulars of the blades, the general flying qualities and results obtained. The performance is also calculated and comparisons are made with performance tests and glides. The ratio of rotor lift to drag is discussed. Part 2 covers general blade motion in gliding flight, taking up the effect of blade twist on the characteristics of the autogiro, a calculation of blade bending, the measurement of blade motion in steady flight and the results of these studies. Three appendices take up the pilot's notes, the measurement of parasitic drag and modifications to the rotor theory for correction of various approximations. *R. & M., No. 1859*, price 10*s.*

Flight Tests of a Falcon Fitted With an Irving Flap. J. Cohen and S/L H. P. Fraser. This paper refers to flight tests on the Irving flap to determine how nearly it approached the ideal of providing a range of settings over which the lift is constant but the drag variable within wide limits with low operating forces. By fitting the flap across the span of a standard Falcon inboard of the ailerons, changes in gliding angle and trim caused by the flap were determined, as well as its contribution to maximum lift. The operating force was measured and the linkage and chord ratio were varied to reduce the operating force to a minimum. The flap movement was kept within the constant lift range by means of a "gate" and the effect of variable drag was explored.

It was found that the lift due to the

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flap increased uniformly up to the half-open position and thereafter remained constant, while the drag increased steadily. The total gliding angle change was 3½ deg. and trim change was negligible. The aerodynamic hinge movement was not as low as would be indicated by calculation for this type of flap. Tests showed that it would be reduced if the chord ratio of the upper to the lower member were increased from 1 to 2. The present flap, being quickly and easily operated, enabled pilots to reach a given point at a given speed without side slipping, S-turns or use of the engine. Pilots who tested the flap pronounced it a help in facilitating the landing approach and suggested that much more drag could be used advantageously.

The feasibility of controlling the gliding angle with a rapidly adjustable flap giving variable drag at constant lift was established. Quick movements were found to be possible with the present Irving mechanism for airplanes weighing up to about 3,000 lbs. The flap used with the Falcon was sufficiently large to show its advantage over the nonvariable flap but not large enough to permit full advantage to be taken of the landing technique used. A suggested modification considerably reduces the operating load and makes the flap applicable to larger and more heavily loaded aircraft. *R. & M., No. 1863*, price 2*s.* 6*d.*

Some Experiments on the Balancing of Wing Brake Flaps. H. B. Irving and G. A. McMillan. This report deals with two proposed methods of balancing flaps, the Miles or front- and rear-hinge method, and the double-hinge method. The hinge moment or operating force for both of these methods of balancing was measured, including an arrangement of the double-hinge flap as an upper surface spoiler-aileron. The outstanding results of the experiments with the front- and rear-hinge method were the rapid rise in the hinge moment on the front flap as soon as its leading edge moves away from the wing surface. The moment tending to open the flap almost reaches its maximum value for a flap movement of less than 10 deg. Therefore, a close balance could not be attained over a large range of flap movement without using a compensating mechanism.

The double-hinge method of balancing indicates the possibility of a reduction of the force required to operate the flap to a value between one-sixth and one-eighth of that for the unbalanced split flap. The degree of balance can be varied within certain limits by adjustments of the positions of the hinges and it does not appear to be critical, varying little with incidence.

Arranged as an upper surface spoiler-aileron, the double-hinge flap was not so closely balanced as the corresponding brake flap. However, closer balance could probably be obtained by adjustment of the hinges. Variation of balance with incidence was small and was scarcely affected by the presence of a full-span brake flap over the normal flying range. Operating forces fell to small values beyond the stall, the tendency of the flap being to open. *R. & M., No. 1864*, price 3*s.*

Wind Tunnel Corrections on Ground Effect. W. S. Brown. A model monoplane was tested in the Duplex Wind Tunnel, the investigation covering wings and tail setting. For wings, general formulas for wind-tunnel corrections and corrections to ground effect were obtained for wings of any span and in any horizontal plane in a closed rectangular wind tunnel assuming uniform loading. Numerical values of the corrections were obtained in specific cases and results were worked out in detail for tunnels having height-breadth ratios of 1 to 2 and 1 to 4.

For tail setting, similar formulas were obtained for tail down-wash corrections with the wing and tail in any two parallel horizontal planes. Numerical values are given for a monoplane of span-to-tunnel breadth 0.4 and tail - leverage - to - tunnel breadth 0.16, in tunnels of ratio 1 to 2 and 1 to 4.

With reference to the model tested it is concluded that corrections on ground effect were sufficiently small to be within the range of experimental error, but in other instances this might not be the case. *R. & M., No. 1865*, price 4*s.* 6*d.*

The Influence of Wing Taper on the Flutter of Cantilever Wings. W. J. Duncan and C. L. T. Griffith. The investigation in this report is an extension of one by the same writers published in 1937. In the earlier paper the taper ratio and the position of the flexural axis in the chord were constant but in this investigation both of these are varied. Results are presented in 51 diagrams in which the nondimensional flutter speed coefficients are plotted against the modified stiffness ratio. Curves giving the ratio of the frequencies of the predominantly flexural oscillation in still air are added to the diagrams. This facilitates the estimation of critical flutter speeds from the results of resonance tests made in still air. Several cross-plottings of the results are also included. The most important conclusion is that the nondimensional flutter speed coefficients do not vary greatly with wing taper within the range of taper ratios considered. *R. & M. No. 1869*, price 4*s.* 6*d.*

Tests on Two Joukowski Sections in the Compressed Air Tunnel. D. H. Williams, A. H. Bell and A. F. Brown. Tests are described on two Joukowski sections, 12.7 per cent and 23.6 per cent thick. These have been tested up to $R = 8 \times 10^6$, having the usual rectangular plan form. The thicker wing was also tested with rounded wing tips. It was found that on the thicker wing with square ends maximum lift is uncertain above $R = 4 \times 10^6$, where any value between 1.05 and 1.15 can be obtained. On the same section with rounded ends, maximum life is definite but about 5 per cent lower than that of the square-ended wing up to $R = 4 \times 10^6$. It is slightly lower than the smallest values for the square-ended wing at higher values of R.

For the wing with rounded ends, minimum drag is lower than for the rectangular wing by 0.0014 at $R = 8 \times 10^6$ and by 0.0020 at $R = 0.3 \times 10^6$. Measurement was also made of profile drag by the pitot traverse method, the measurements on the thin wing agreeing with the balance results. Measurements on the thick wing agree with the balance results on the wing having rounded ends. Comparisons were made of the results on the two types of supports for models, end pips and V's by testing on both types the thick wing having square ends and good agreement was found. *R. & M., No. 1870*, price 2*s.* 6*d.*

The Royal Aircraft Establishment Blower Tunnel. D. W. Bottle. This paper contains a description of a blower wind tunnel so built that it can be used for tests involving the use of liquids which would damage a normal wind tunnel. A jet of 2.5 ft. in diameter is provided with a maximum wind speed of 200 m.p.h. Water sprays have been installed which permit of the simulation of rain conditions. The power factor, velocity distribution and static pressure gradient are given. *R. & M., No. 1871*, price 1*s.*

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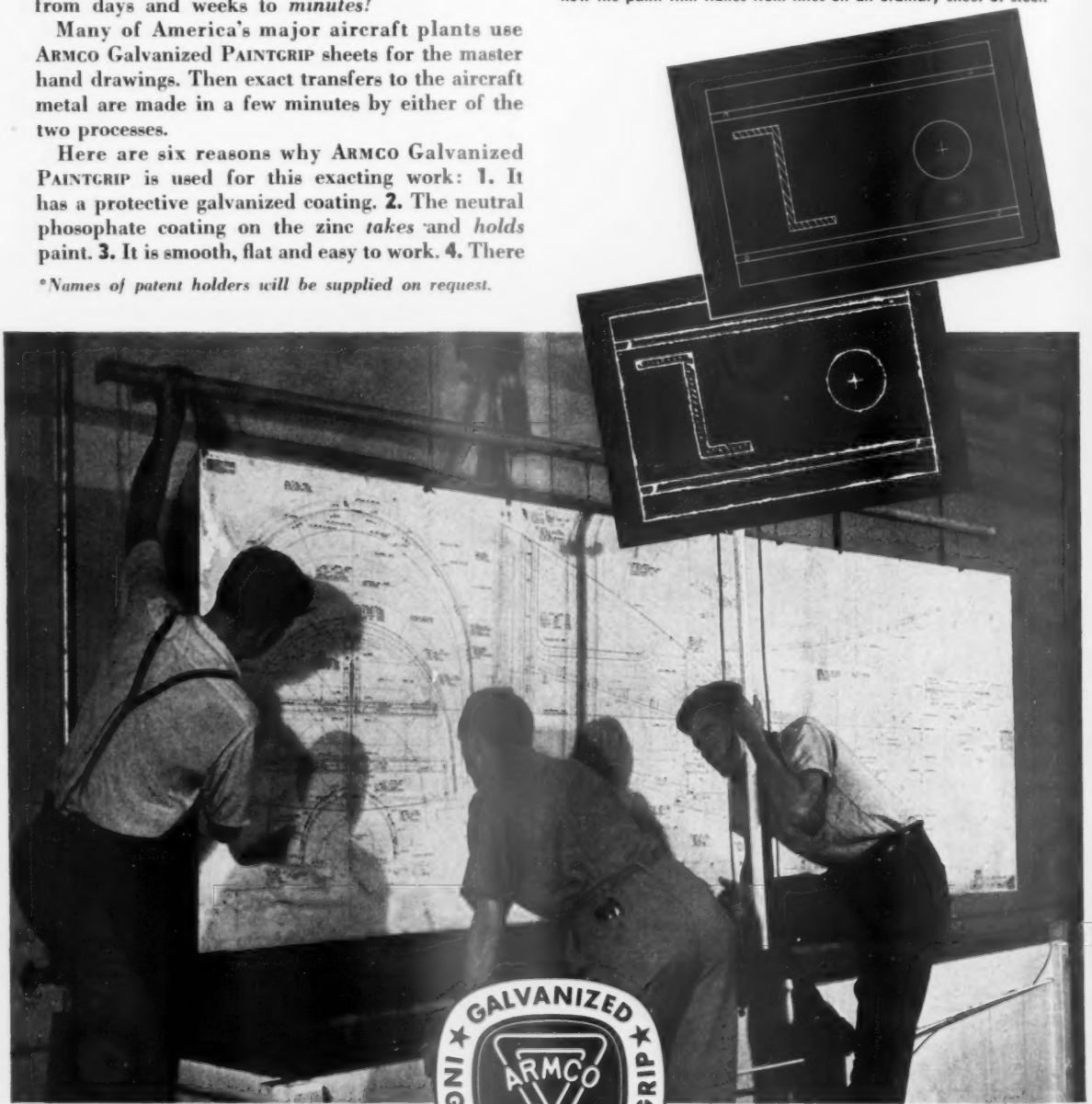

Help Wanted

In this book the author provides a readable guide for women seeking careers in aviation. First, the jobs that women can do in and around aircraft and the Civil Air Patrol and its bearing on the national war effort are explained. An outline is also offered of a program for learning to fly and methods for turning that skill into useful service as instructors and in other key defense jobs. Besides flying assignments, women can serve as radio technicians, meteorologists, and mechanics.

The special qualifications required for aeronautical secretaries, bookkeepers, clerks, salespeople, and dietetians and the rewards for particular qualifications are presented. This book differs from the run of "girl career" books in that it was written by a woman with practical aeronautical experience. The author spent her aviation career in many of the jobs outlined and witnessed the growth of many more of them. For that reason, the book retains, throughout, a flavor of authenticity.

Needed—Women in Aviation, by Dickey Meyer; Robert M. McBride and Company, New York, 1942; 219 pages, $2.00.

Handbook Revision

The fifth edition of this text on aircraft engines and equipment issued by the author since 1917, this volume was calculated to close the gap since the last revision in September, 1929, but was prepared prior to the entry of the United States into the war. Numerous changes in the design of the major parts of airplanes such as engines, propellers, landing gear and other components of construction have made it seem advisable to the author to confine this volume largely to matters of power plant maintenance and related details coming within that range. To other authors have been left the consideration of such phases of the science as aerodynamics, design and construction of airplanes and other technical studies, but this book is intended to assist the ground mechanic in his work of keeping in the best condition the parts that are included in the scope of his duties. It contains a detailed study of power plants, accessories, propellers, parachutes, instruments, inspection and maintenance, applying equally to fighting and to transport aircraft.

After studying the general engine theory, it examines the construction, operation, maintenance and overhaul of such typical engines as the Allison, Pratt & Whitney Twin-Wasp, Rolls-Royce, Wright Cyclone, Lycoming, Menasco Ranger, Kinner, Lambert and Warner engines, as well as the smaller engines.

The theory and application of carburetion, ignition and starting are examined, as well as the modern electric and hydromatic propellers, engine and flight instruments, and practical procedures for their operation and maintenance are given. A chapter is included on airline maintenance, parachute packing and repair and general aircraft standards.

Aircraft Handbook, by Fred H. Colvin; McGraw-Hill Co., Inc., New York, 1942; 784 pages, $5.00.

Books reviewed in this section may be purchased, or borrowed without charge, from The Paul Kollsman Library, Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York, N. Y.

Avigational Exercises

This book is a typical primary exercise text for student air navigators. It gives the basic definitions and abbreviations, explains the course, track, and bearings, and has a series of practical exercises and examples which apply most of the common avigational processes.

The procedure is direct. The lesson simply states the process it is explaining and then applies it to an actual place on the map. This is followed by a similar example for the student to work for himself.

It was evidently not the author's intention for this book to stand alone. It is, however, a necessary link in avigational education; a series of basic applications of primary lessons, to be worked out on the ground and perhaps, later, in the air.

Air Navigation, by M. J. Hearley; Longmans, Green and Co., New York, 1942; 90 pages, $1 75.

Sheet Metal Handbook

Organized from a teaching standpoint, beginning with the simplest processes and leading on step by step to the more difficult jobs, this is a presentation of the fundamentals of airplane sheet metal processes. Since its instruction is based on the theory of motivation, it contains explanations of why things are done as well as how to do them.

This text offers a survey of cutting, filing, forming, riveting, finishing, and assembling. For the benefit of the student it is supplemented by photographs, drawings, and a set of questions at the end of each chapter which affords him the opportunity to test his mastery of the subject.

How to Do Aircraft Sheet Metal Work, by Carl Norcross and James D. Quinn, Jr.; McGraw-Hill Book Company, Inc., New York, 1942; 285 pages. $2.20.

Assembly Problems

Rather than promulgating hard and fast rules regarding aircraft assembly, this is a guide to information that will help the operator solve any given assembly problem in the most efficient manner. It is a discussion of the types of construction that may be employed—truss, geodetic, stressed-skin, and monocoque—and the variety of materials used.

Subject headings of the book include: assembly procedure; design; equipment; riveting and bolting; wing leading-edge, trailing edge, and tip assembly; control-surface assembly; wing, float, and tail assembly. Information on fuselage and hull assembly, landing-gear assembly, and final assembly comprise the concluding chapters of the text.

Aircraft Assembly, by C. F. Marschner; Pitman Publishing Corporation, New York, 1942; 104 pages, $1.00.

Elementary Aerodynamics

This text, written in comprehensive nontechnical language, seeks to elucidate the theory and practice of aerodynamics as applied to model flight. While clarifying the essential difference between the aerodynamics of slow-speed miniature aircraft and that of high-

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speed large aircraft, it serves as a background for the further study of aerodynamics for functional airplanes.

Pertinent data in this book provide the results of actual wind-tunnel tests covering model airplanes. In its simple exposition of the aerodynamic factors affecting performance, it surveys the drag of objects at low speed; airfoil characteristics of low-speed wing sections; aerodynamics of the wing; simple blade element theory; aerodynamic design of model propellers; lateral, longitudinal, and vertical stability.

Covering the same basic information taught in Government-approved ground schools, this presentation is intended to introduce the theory of flight.

Aerodynamics for Model Aircraft, by Avrum Zier; Dodd, Mead and Company, New York, 1942; 259 pages, $3.00.

Meet Our Air Forces

This is an introduction to the fighting air units of the United States. . . . The Army Air Forces and the Naval Air Force which includes Marine Corps and Coast Guard aviation. Objectively reviewing our air power, it explains the organization of the various forces, the training of enlisted men and officers, air warfare, air defense, and the contributions of the Civil Air Patrol. The presentation of a short history of the war airplane and America's role in its development is succeeded by a discussion of various related subjects such as aerial photography, gliding, parachutes and balloons. The pertinent question of a unified air command is also discussed.

What the Citizen Should Know About the Air Forces, by Lt. Col. Harold E. Hartney; W. W. Norton & Company, Inc., New York, 1942; 226 pages, $2.50.

Evaluation of U.S. Air Strength

Written since the United States' entry into the war, this book accepts the supposition that the decisive points of the conflict will be in the air and offers an analysis of both American resources and American needs in meeting this challenge. An attempt is made to present the facts unvarnished—without theory and without prophecy.

Following its design to interpret what the air war is, *Thunder Aloft* relates what America's contributions are in terms of plans, fliers, airplanes, supplies and morale. It answers a multiplicity of concrete questions that the average civilian is asking: how good is a Fortress or an Airacobra or a P-40 . . . . what handicaps or advantages do our fliers have . . . . what is the function of a carrier . . . . what are the chances of American cities being bombed . . . . how do we get new airplanes to the fighting fronts . . . . how does the bomb-sight work . . . . what will one shell from an Airacobra's cannon do to an enemy airplane?

Thunder Aloft, by Kent Sagendorph; The Reilly & Lee Co., Chicago, 1942; 300 pages, $2.50.

Science of Weather

Incorporating information gleaned from man's new knowledge of extremely high altitudes, this is a scientific treatment of weather prediction and an analysis of why weather behaves as it does. The text contains a graphic explanation of the envelope of air in which we live and the means and instruments through which it is explored. Of special interest is a first-hand account of stratosphere flights with which the author was closely connected.

Detailed instruction in the science of weather forecasting, which has developed enormously in recent years, enables the reader to interpret a weather map intelligently. It shows him how to draw one himself, how to construct a home weather observatory, and how to predict the weather from local signs and observations.

Air-mass-and-front analysis is embodied as an innate element of the book's whole outlook. Crediting the sun and its variations as the ultimate primary cause of all earthly weather, consideration is taken of possible connections between solar chords and earthly echoes.

Weather and the Ocean of Air, by William H. Wenstrom; Houghton Mifflin Company, Boston, 1942; 484 pages, $4.50.

Aircraft Sheet Metal Textbook

Dedicated to mechanics engaged in the aircraft industries and to those in training for such work in public and private aeronautical schools, this textbook is intended for pre-employment, trade-extension and rehabilitation training of workers for aircraft factories, airline maintenance and repair shops and Army and Navy aircraft repair bases. It is the fifth of a series of six books dealing with the metal work entering into airplane construction.

Part I covers related trade information for sheet metal repair work under the headings of aluminum and its alloys, rivets and riveting practice and methods of repair for the internal and external metal parts of the airplane. Part II deals with sheet metal repair shop practice in the form of 25 specific job assignments on which general information and exact job operation sequences are given. Part III gives general data on equipment, tools and measurements. Illustrations include working drawings and photographs showing the aircraft parts before and after repairing.

Airplane Metal Work—Vol. 5: —Airplane Sheet Metal Repair, by Alex M. Robson; D. Van Nostrand Company, Inc., New York, 1942; 94 pages, $1.25.

Sheet Metal Work Course

Although the course presented in this book is not intended to train journeymen aircraft mechanics, it is suitable for assisting men and making them acceptable trainees for an aircraft factory. It has been the aim of the authors to present to the student the information that he will actually need and to develop sufficient skill in the work assigned to him to maintain a satisfactory flow of material through the plants.

The lesson-sheet technique is used, making it possible for the student to utilize the material as a home-study course. For classwork it has the advantage of permitting each student to progress at his own speed, leaving the instructor free to give individual help where it is required. This method has the further advantage of permitting faster students to maintain their interest while not discouraging the slower ones.

The book is developed as a series of 17 projects, so written that they demonstrate the most common types of riveting methods. Each project constitutes an assembly in itself, requiring the student to make the assembly according to drawings provided. The sequence of the projects is developed in such a way that each is a little more difficult than its predecessor and requires more auxiliary knowledge, thus providing a gradual and steady progress in learning.

Unit one is devoted to assembly operations; unit two covers the properties of aluminum and its alloys and other metals; unit three includes instruction on the development of templates and principles of blueprint reading; and unit four comprises exercises in blueprint reading.

Practical Aircraft Sheet-Metal Work, by R. H. Frazer and Orrin Berthiaume; McGraw-Hill Book Company, Inc., 1942; 193 pages, $3.00.

Primary Welding Text

Based on the author's experience as a practicing welder in several aircraft factories and five years as an instructor in industrial night school and special national defense instruction units, this book presents a compendium of those fundamental principles of oxyacetylene welding which are universally accepted by the aircraft industry.

Cherry Blind Rivets

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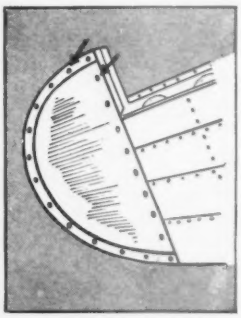
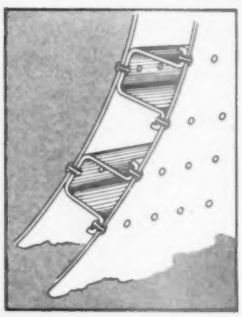


Every plane built has its own hard-to-get-at spots for the riveter. Some of these can be worked on from one side only, with no possible chance to use a bucking bar.



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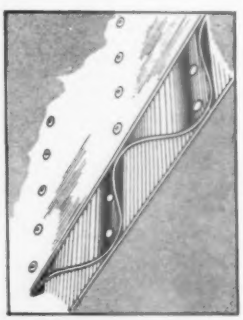

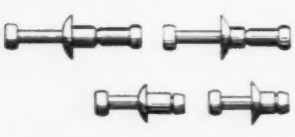

From left to right above, the self-plugging type with brazier and countersunk heads—below, the hollow type with both styles of heads. All are applied with hand or power guns.

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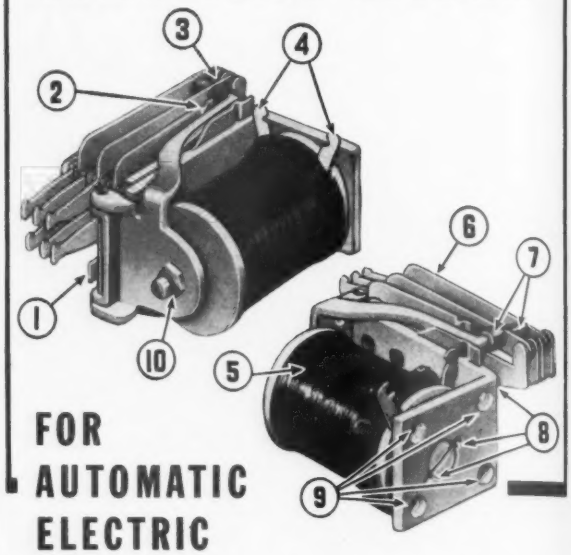

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Designed as a classroom text, it describes first the nature of the welding gases, the torches, valves, lines and other equipment, the flames and their use and adjustment. The hand tools and standard fastenings are also discussed, as well as the physical and metallurgic properties of the weldable alloys.

A chapter is devoted to the examination of characteristics of various types of welds and their application to different types of airplane structures. Among the other phases of applied welding studied are the effects of stress on welded structures, the construction and use of welding jigs, methods of construction and specific instructions for welding aluminum alloys and stainless steel.

While the book does not attempt to teach physical welding, reserving that for the practical instructor, it does outline actual problems in the welding of chrome-molybdenum and stainless steel and aluminum, the practices outlined covering virtually all of the welds one would encounter in aircraft production or repair.

Directions for the reading and interpretation of drawings and blueprints and frequently used reference tables are also included in the text.

Aircraft Welding, by L. S. Elzea; McGraw-Hill Book Company, Inc., New York, 1942; 121 pages, $2.00.

International Air Transport

The influence of air transportation on international relations after the war promises to be as revolutionary as the influence of the air weapon has been in actual warfare, according to the author, who traces the history of commercial aviation and attempts to answer questions on the international, political and economic consequences of the introduction of this method of rapid transportation. Considerations that have had a bearing on past air transportation policies of the nations are set forth and determinations of policy are explained in the light of those considerations. Obstacles that stand in the way of future improvement in political conditions governing and limiting the development of air commerce are identified and elements are reviewed with respect to their influence on national policies controlling future air operations.

Part I is devoted to national interests in air transportation, Part II to governmental promotion and control, Part III to air transport in the Western Hemisphere and Part IV to the diplomacy of air transport and the freedom of the air.

International Air Transport and National Policy, by Oliver James Lissitzyn; Council on Foreign Relations, New York, 1942; 478 pages, $5.00.

Arc Welding Text

While this book does not deal with any specific aircraft phase of arc welding, the increased use of this technique in the production of fittings, fuselages and fuselage sections and more recently, entire structural members, makes this general text useful. The book is divided into five sections, Part I being devoted to general welding information. Material covered includes the growth of arc welding; where arc welding is used; manufacturing applications; available metals and alloys; discussion of joints and welds; electrodes and filler rods; strength of arc welded joints; cost of arc welding; characteristics of the welding arc; welding symbols and their use; equipment for arc welding; development of welding personnel.

Parts II and III of the textbook are devoted to the complete series of arc welding lessons exactly as they are offered in the Hobart Trade School. This group of 41 lessons covers preliminary instructions; starting and manipulating the arc; common joints with bare electrodes; welding light gauge sheets with coated electrodes; welding with coated rods in all positions; pipe welding; welding cast iron; special tests; welding with the carbon arc; "long arc" method of welding copper; and specialized applications of arc welding.

The concluding sections contain a complete dictionary of welding terms and twenty pages of helpful tabular data for operators and designers.

Practical Arc Welding, by W. J. Chaffee; Hobart Trade School, Inc., Troy, Ohio, 1942; 516 pages, $2.00.

Military Flying Vocation

Written by Lt. Gen. H. H. Arnold and Brig. Gen. Ira C. Eaker, this book is intended as a guide to a career in the U.S. Army Air Forces. It paints a realistic picture, portraying for the neophyte not only the opportunities and advantages that are to be derived from his new profession but also the duties and responsibilities that will be exacted of him. Life as a military airman is traced from recruit days to the achievement of a general's rank, from the "don'ts" of a flying cadet to the "musts" of a tactical command. Also demonstrated is how changes in national life, international negotiation, and the course of military history have been wrought by the crescendo of vast air forces.

The first part of the book, concerned with orientation, outlines an army air vocation, follows a model career from cadet, through graded ranks to retirement and proffers helpful advice for meritorious achievement. Part II, giving career details, is separated into the early years, the middle years and the waning years, with a supplementary consideration of specialties for junior airmen that lead to special assignments. The concluding section is devoted to air warfare and a discussion of the flier in combat, successful air tactics, and strategy.

Royalties from this book are being deposited in the Army Air Forces Aid Fund to assist widows and children of officers and enlisted men of the Army Air Forces.

Army Flier, by Lt. Gen. H. H. Arnold and Brig. Gen. Ira C. Eaker; Harper & Brothers, New York, 1942; 299 pages, $2.50.

Winning by Air

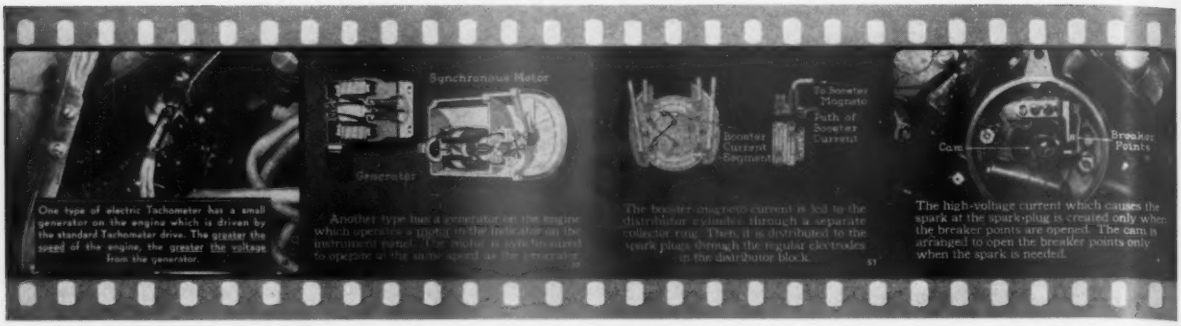
In this book the author sets forth his opinions on the steps to be taken by the United States in revising the nation's war strategy and tells how the war can be won in the air. In explaining how this country is particularly well equipped to produce and use air power as the most decisive and effective weapon ever invented, he reviews the crucial campaigns and battles of the war to date and shows that air power has been the instrument of victory in every case.

He holds that America can manufacture aircraft capable of flying to the capital of any enemy country, dropping their bombs and returning to home bases. Deploring the failure to unleash that power and to use that potential might which would turn the tide of the war, he criticizes the policies of reliance upon land power and sea power, urging that tradition-bound thinking and planning be laid aside and the modern technique adopted. It is brought out that even large battleships have been destroyed by aerial attack and that naval concentrations are particularly vulnerable, inviting assault from the air instead of affording protection against it.

A plea is made for a separate air force and a unified high command on the basis that the planning of air strategy requires the specialized knowledge of aeronautical experts. The elimination of land and sea forces is not recommended, but the coordination of all three arms under a single high command is suggested. The author urges that the offensive be assumed at once under the leadership of air power.

Taking an affirmative point of view, this book puts forth the idea that the setbacks suffered to date may prove beneficial as lessons for the guidance of future policy and outlines a strategy of victory which, in the author's opinion, will assure the final triumph of this nation and its allies.

Victory Through Air Power, by Major Alexander P. de Seversky; Simon and Schuster, New York, 1942; 354 pages, $2.50.


One type of electric Tachometer has a small generator on the engine which is driven by the standard Tachometer drive. The greater the speed of the engine, the greater the voltage from the generator.
Synchronous Motor
Generator
Another type has a generator on the engine which operates a motor in the indicator on the instrument panel. The motor is synchronized to operate at the same speed as the generator.
To Booster Magneto
Path of Booster Current
Booster Current Segment
The booster magneto current is led to the distributor cylinder through a separate collector ring. Then it is distributed to the spark plugs through the regular electrodes in the distributor block.
Cam
Breaker Points
The high-voltage current which causes the spark at the spark-plug is created only when the breaker points are opened. The cam is arranged to open the breaker points only when the spark is needed.

Typical examples chosen at random from 45 slidefilms of the Mechanic's Slide Film Course prepared by The Jam Handy Organization.

Mechanic's Slidefilm Course

At the request of the Special Educational Devices Department of the U.S. Navy Bureau of Aeronautics, a slidefilm course on various mechanical operations connected with aircraft maintenance was produced by The Jam Handy Organization.

In the general handling, it is similar to the Civilian Pilot Training film brought out by the same producer about a year ago. It consists of a strip of standard 35-mm. film on which an illustration, either photographic or diagrammatic, is printed along with part of the text. Projected through a standard slidefilm projector, it can be used for ground school lecture material or as an individual reference subject by means of an optical viewer.

Forty-five slidefilms are offered covering many of the basic maintenance and repair operations. To illustrate the thoroughness of the system of handling, the subject "Preparation for Fabric Covering" studies the structure of the rib and the wing itself, indicates how cross-tape is attached in wood and dural structures, and shows dope-proofing with dope-proof paint, cellulose tape, metal foil and other materials. The general procedure in estimating the amount of fabric used in a particular covering job, including seam allowances estimating tape and measuring total lengths is also outlined.

Various phases of covering and doping, the mixing and handling of glue joints, soldering, tube bending and fitting, cable splicing, and the use and care of spraying equipment are examined. Other subjects include studies of flight and engine instruments, airplane tires and landing gear equipment, brake adjustment and the like. Large parts of the course are devoted to basic drafting, studies of the airplane engine, its operation, care and overhaul, the airplane control system, the fuel system, fueling procedures and lubrication, as well as rather detailed examination of tools and their use and the properties, handling and care of the various alloys and metals which make up the modern airplane.

While this lecture series evidently assumes that the student does not possess any previous knowledge of the subjects presented, it presupposes that the audience has access to expert instruction, competent advice and a good library. In conjunction with these, this course offers both a compact introduction to some of the hard-to-explain phases of maintenance and a quick preexamination review for both military or civilian mechanics.

Visual Aids for Aviation Training; The Jam Handy Organization, Detroit, 1942; 45 subjects, $3.00 to $3.50 each.

British Avigation Text

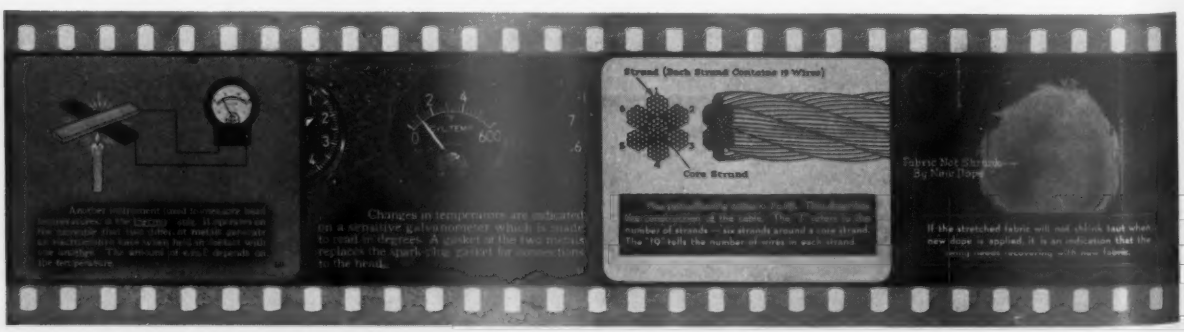
A new two-volume addition to the "British Aeroplane Maintenance and Operation" series, these books act as primary and intermediate avigational text. The basis for air navigation, air pilotage by landmark and by dead reckoning is introduced, as well as the making and interpretation of maps. This is followed by an examination of the primary flight instruments.

Chapters on more advanced systems of avigation, celestial systems and the application of radio aids are introduced and applied in a section on long-range overwater flights. A cursory study of meteorology and a summary of conditions governing the granting of British air navigator's licenses conclude the first volume.

The second volume begins with a closer study of the magnetic compass and its standard aircraft variations, such as the Holmes Tele-compass, the Brown Static-Gyro and the earth inductor compasses. Other chapters discuss the causes and corrections for compass error, standard avigational calculators and computers and drift sights, and the use of the sextant.

The relative merits of ground and airplane directional systems are compared, and the standard procedure in flying radio ranges and the various systems of blind approach are also presented. The concluding chapter outlines the standard British procedure for night flying, using flare paths, floods, instruments and standard ground facilities.

Air Navigation, edited by E. Molloy; Chemical Publishing Co., Inc., Brooklyn, N. Y., 1942; Part I, 128 pages; Part II, 132 pages; $2.50 each.


Another instrument used to measure heat conservation is the Kipp-Zonen, with 12 spheres on the principle that two wires of metals generate an electromotive force when held in contact with one another. The amount of e.m.f. depends on the temperature.
Changes in temperature are indicated on a sensitive galvanometer which is made to read in degrees. A gasket of the two metals replaces the spark-plug gasket for connections to the heads.
Strand (Each Strand Contains 19 Wires)
Core Strand
The yellow identifying colour is 7-fil. This describes the construction of the cable. The '7' refers to the number of strands — six strands around a core strand. The '19' tells the number of wires in each strand.
Fabric Not Shrunk — By New Dope
If the stretched fabric will not shrink taut when new dope is applied, it is an indication that the

Book Notes

Women with Wings, by Charles E. Planck; Harper & Brothers, New York, 1942; 333 pages, $2.75.

This history of the distaff side's contribution to aviation is told in terms of brief portraits. It is a roll call of women who have aided in the development of aeronautics from the days of the pioneer flyers to their present place in helping to design, build, and fly airplanes.

Falling Through Space, by Richard Hillary; Reynal & Hitchcock, Inc., New York, 1942; 269 pages, $2.50.

The author's experiences as an R.A.F. pilot serve as a picture of the impact of war upon the individuals who are waging the front-line battles. This story of training days, combat ordeals, and a long convalescence moves through the period of appeasement and complacency to the days of *blitzkrieg* when the reserve British squadrons roared into action.

It is also a revelation of the author's theory that the pitched struggles between fighter planes are a return to the days when battles were fought by knight-versus-knight and wars depended on the wit and ability of individuals.

Vauxhall Gardens, by James Granville Southworth; Columbia University Press, New York, 1941; 199 pages, $2.75.

A history of the Royal Gardens at Vauxhall covers that period in the social life of England from the time of Addison and Pepys to the time when entertainments were given at the gardens in the manner of the modern circus. Several of the early balloon ascensions and balloon races held from the Vauxhall Gardens are described.

How to Run a Lathe, by J. J. O'Brien and M. W. O'Brien; South Bend Lathe Works, South Bend, Ind., 1941; 128 pages, $0.25.

The forty-first edition of a handbook on the care and operation of a screw-cutting lathe, tracing the history and development of the tool and giving instructions on its use. Chapters are devoted to setting up and leveling the machine, its principal parts, lathe tools, taking accurate measurements. plain turning, chuck work, taper turning and boring, drilling, reaming and tapping, cutting screw threads, and special classes of work.

Airport Construction & Operation Reference; Occidental Publishing Company, Ltd., Los Angeles, Calif., 1942; 80 pages, $1.00.

The second annual edition of a functional handbook has three major features designed to facilitate its use by busy engineers and executives. The table of contents serves as a general guide to the material, following which there is an airport equipment buyers' directory. At the end of the book there is an editorial index of reference data, arranged alphabetically and in considerable detail. The text material is organized within this index in such a manner as to make readily available the information sought on a specific subject. Airport design factors, surfaces, buildings, lighting, communications and traffic control, and operations are the general heads under which the text matter is presented.

From Covered Wagon to Streamliner, by Edward Hungerford; The Greystone Press, New York, 1941; 64 pages, $1.75.

An illustrated history of railroading in the United States, from the first appearance of the Conestoga wagon to the latest examples of luxurious steam, electric, and Diesel-powered passenger trains.

Adventure Was the Compass, by Alma Heflin; Little, Brown and Company, Boston, 1942; 285 pages, $2.75.

An amusing account of a light plane trip to Alaska made by two girls.

Civilian Defense of the United States, by Col. R. Ernest Dupuy and Lt. Hodding Carter; Farrar & Rinehart, Inc., New York, 1942; 296 pages, $2.50.

This book was written to help civilians learn their jobs as well as the fighting men are learning theirs. It was prepared for the leaders of communities and for every individual who wants to serve his country in this time of need. It covers all phases of organization of the home front, including air-raid precautions, preparation of emergency food supplies, evacuating civilians, combating enemy-inspired rumors, and many other activities.

Physical Constants of the Principal Hydrocarbons, Third Edition, by M. P. Doss; The Texas Company, New York, 1942; 215 pages.

A compilation of tables containing laboratory information on acyclic and cyclic hydrocarbons. Information is given on melting points, boiling points, viscosity, specific gravity, specific heat, aniline point, critical pressure, temperature and density, flash point, and numerous other properties.

America Organizes to Win the War; Harcourt, Brace and Company, New York, 1942; 395 pages.

A symposium by scientific, political, and economic leaders on the causes and fundamental issues of the war, what is being done in every phase of national life to win it, and plans for peace. Contributors include President Roosevelt, Vice-President Wallace, John Chamberlain, Henry Steele Commager, David Cushman Coyle, Alvin E. Dodd, Paul de Kruif, Ladislas Farago, Dorothy Canfield Fisher, Charles H. Judd, Prime Minister Churchill, Secretary Wickard, Waldemar Kaempffert, Max Lerner, Lauren D. Lyman, S. L. A. Marshall, Arthur Upham Pope, Byron Price, Paul Schubert, Frederick L. Schuman, Harold M. Vinacke.

Airplane Design, Sixth Edition, by K. D. Wood; Cornell Co-op Society, Ithaca, New York, 1941; $4.50.

Sixth edition of a textbook on airplane layout and stress analysis calculations with particular emphasis on economics of design. Included in appendix form are much of the data necessary for a student to carry a design project through its preliminary stages.

Modern Gun Production by Arthur F. Macconochie; Penton Publishing Company, Cleveland, 1941, reprinted from *Steel;* 51 pages, $1.00.

This, the third of a series of reprint handbooks on the production of war materials, is devoted to the principles of the construction of guns, the actual manufacturing operations as carried out at the Watervliet Arsenal and at the Struthers Wells-Titusville Corporation, the design and construction of gun carriages, recoil mechanisms, range-finders and fire-control instruments.

Air Mail Magazine for 1941; A. Phillips, Newport Mon, England, 1941; 239 pages, $0.50.

A bound volume of this magazine devoted to the hobby of collecting first air-mail stamps and covers and to the progress of civil aviation. It contains articles of interest to philatelists specializing in air mails; illustrations of stamps, covers, and postmarks; portraits of some famous flyers; and price lists of stamps, covers, and other items.

Automotive Occupations, by Captain Burr Leyson; E. P. Dutton & Co., Inc., New York, 1941; 190 pages, $2.00.

Advice and assistance for young men seeking careers in the automotive industries. Various occupations in each division of the business are defined to give the young reader a picture of the requirements and opportunities in this field.

To Those Who Fight

• America's pledge to those who fight is a pledge of ever-increasing production. A swiftly rising tide of weapons, of aircraft, ships, guns, tanks and accessories, is essential to the successful prosecution of the war. Breeze, with all its plants now devoted to production for defense, is meeting the demands of the U. S. Army, Navy and Air Forces, is turning out in quantity high quality Breeze products for service on land, on the sea and in the air. Breeze Shielding, Electrical Connectors, Flexible Conduit and Fittings, Aircraft Armor Plate, and Cartridge Engine Starters, as well as the many other items of Breeze equipment, are today giving dependable service on all fronts to those who fight for Democracy.

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From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Acme White Lead and Color Works

A new product, Acme Quality Industrial Finish Flash-Off No. 99, which is designed to eliminate weld spatters and the time and cost of removing them, has just been introduced by the Acme White Lead and Color Works.

The mechanic simply brushes, sprays, or wipes on Industrial Finish Flash-Off along the edges of the metal surfaces to be joined by the weld. Then when the welding is done, metal chips bounce or fall off instead of adhering to areas adjacent to the seam. This is said to eliminate the necessity of grinding or scratching these chips off. Being an excellent conductor of electricity, the Flash-Off helps prevent the weld arc from breaking, a feature that does much in producing a stronger seam. An additional feature of the new product is its cleansing effect on the surface to which it is applied. It prevents pitting on galvanized or ungalvanized metal surfaces and permits immediate application of paint without cleaning operations other than wiping off.

Aero Industries Technical Institute

Hundreds of specially selected U.S. Army men are to be trained at Aero Industries Technical Institute, Los Angeles. The contract for the large-scale training program was awarded by the Air Service Command. The men are being trained in specialized phases of aircraft and engine maintenance. After receiving their training, the mechanics will serve at Air Corps maintenance depots and stations.

Aero Industries Technical Institute is closely identified with the aircraft industry through its Executive Management Board. John K. Northrop, President of Northrop Aircraft, Inc., is chairman of this board, which has two other members, C. A. Van Dusen, former First Vice-President of Consolidated Aircraft Corporation and Robert E. Gross, President of Lockheed Aircraft Corporation. Addition of the Army men to the school's civilian engineering and mechanics students will approximately double the number of men being trained. To supplement the eight large buildings now housing the Aero Tech. training facilities, an 18,000 sq.ft. hangar-type structure for practical shop work, six barracks, mess halls, kitchens, a canteen and a recreation hall will be constructed.

American Silver Producers' Research Project

Extensive tests by Handy & Harman, now directing the American Silver Producers' Research Project, have proved that joints brazed with silver alloys are readily made stronger than the metals brazed. This is not always true of ordinary butt joints, but can be made true of lap and scarfed joints, providing the length of lap or scarf is made adequate. Even butt joints produced by brazing stainless steel to stainless steel with a silver alloy have, when properly made, been found to yield a tensile strength as high as 134,000 lbs. per sq. in.

The design and especially the area of the joint is probably the most important factor controlling its strength, but it is far from being the only factor. Other factors include the kinds of metal joined, the clearances between parts and, in some cases, the skill of the operator who does the brazing. All these factors can be controlled within reasonable limits. Research has shown that, under most conditions, a joint has maximum strength when clearances into which the silver alloy is flowed are approximately 0.0015 in., but in tests using stainless steel and a silver brazing alloy as indicated above, any properly made joint under 0.005 in. clearance was found to have at least 100,000 lbs. per sq.in. tensile strength. With many metals, even a butt joint is stronger than the metals brazed, so that the break in a test specimen usually occurs not in the joint but outside it, making the precise strength of the joint difficult to determine.

It has been shown that silver alloys penetrate readily into very small clearances and, since joints made with such clearances are strongest, it is wasteful to provide wide clearances or fillets as is often done with soft solders. It follows that very little brazing alloy per joint is required and that the cost per joint is correspondingly low.

Beatty Machine & Manufacturing Company

The Beatty Hydraulic Forming & Flanging Press has been introduced by the Beatty Machine & Manufacturing Company, Hammond, Ind.

The machine is available in capacities up to 400 tons and features a new self-cooling hydraulic oil system that eliminates the need for cooling coils. The hydraulic oil circuit is so arranged that the two vertical cylinders, each having a 200-ton capacity, can be tied together and operated as a single 400-ton press with operation by one lever control.

When used for flanging, the front cylinder advances to the work on the down-stroke at the rate of 290 in. per min. and holds the work under pressure while the horizontal ram advances at the same rate. Under a full load, this ram presses at the rate of 21 in. per min. All cylinders are controlled by manual valve lever.

Further specifications for the 400-ton model are as follows: maximum daylight of press, 45 in.; stroke of cylinders, 524 in.; depth of throat, 66 in. from center of vertical cylinders to housings. The lower platen is 48 in. right to left; 88 in. front to back. These figures naturally vary with the size of the machine and can be changed to adapt the machine to the particular requirements of a job.

Boeing Airplane Company

More than $1,000,000 worth of material per year is being rescued from the Boeing scrap pile and put back to work building the war machine of the United States. Throughout the nation other

plants are carrying out similar programs. Already enough scrap is being picked up from factory floors to make the difference between steady, uninterrupted production and bottlenecks arising from serious shortages of such materials as aluminum. By July, according to figures released some time ago by the O.P.M., the aluminum scrap salvaged by America's aircraft plants will furnish enough aluminum to build 250 Flying Fortresses and enough magnesium for 500,000 incendiary bombs every month.

The conservation program was set up nationally a year ago when the Government ordered segregation of aluminum scrap, but many industrial plants already were digging into their scrap heaps. Among them was the Boeing organization, where conservation had become a thorough business. The Boeing program makes use of every particle of material. Into the Boeing trash bins go, in the order of their importance, aluminum, stainless steel and plain steel scrap. Steel and dural borings, or metal "sawdust," are swept up around the routers and milling machines and sifted through a screen. An important contribution to the melting pot at the Boeing factory is an aluminum alloy tubing known technically as 52S, valuable for its magnesium alloy. Strips of sheet metal from the punch presses and brass borings from the lathes go into the collection. Kirksite turnings, produced in making dies for the great presses, are taken to a smelter where their steel content is removed and returned to the factory in the form of ingots.

Other items on the salvage list at Boeing include clamps, rubber and metal caps for tubing, bolts, nuts, screws, rivets, metal and iron washers, wood, short pieces of insulated copper wire, burlap, rejected pieces of rubber hose and weather stripping. While much of the larger material is sold, aluminum is returned to its producers, where it is remelted and rerolled.

Cambridge Instrument Company, Inc.

A special exhaust gas tester, designed and built for test-stand use in the aviation and automotive industries has been announced by the Cambridge Instrument Company, Inc. This instrument provides a ready means for making distribution tests and for quickly and accurately determining the efficiency with which fuel is being burned in any or all cylinders of an engine under test.

The complete equipment comprises an indicator having a double scale, $4\frac{1}{2}$ in. long, reading in fuel-air and air-fuel ratios, together with an aero-type analysis cell and wires for connecting these two units, in addition to standard installation parts such as sampling nipples, hose connectors and copper tubing.

Operation of the instrument is based on the thermal conductivity principle of gas analysis. Exhaust gas samples from the engine are conducted through tubing to the analysis cell, where the thermal conductivity of the gas is measured to determine the completeness of combustion taking place in the engine.

Carboloy Company, Inc.

Carboloy tipped rifle drills for 30- and 50-caliber and 20-mm. gun barrels have been placed in production by Carboloy Company, Inc., and output is being stepped up as rapidly as possible. During the experimental production runs carried on since last April, several thousand gun barrels were drilled, and it is stated that output per man-hour was increased substantially.

The new gun drills are to be furnished with the Carboloy tip brazed to a short steel shank which in turn is attached by the users to their regular gun drill tubes. Cutting edges are not finish ground, since experience has shown that optimum angles and other factors will vary among different plants depending on particular machining conditions and materials to be cut. Final cutting edges are therefore ground by the

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individual user just as in resharpening such gun drills.

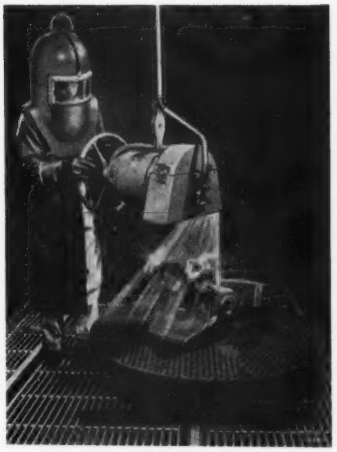
It is claimed that there is less tendency of the Carboloy tipped drill to squeeze tight in the barrel, tending to insure minimum wear on the drill tip. Production experience to date indicates an average of some two dozen 50-caliber barrels per grind of the tip, with an average of 12 to 18 barrels per drill produced per shift. This compares with an average of one barrel per grind with high-speed steel drills, according to field reports to Carboloy.

Until recently, there was little incentive for using carbide tools in the older types of large machines such as boring mills, vertical turret lathes and engine lathes, many of which were designed for intermittent operation and relatively slow speed, having insufficient power and rigidity for high-speed operation. An important item in the present program for speeding production is the adoption of carbide tools for use on older machines, as well as on the newer designs. Numerous advantages obtained through the use of carbide tools on large machines are summarized, including higher cutting speeds, lighter fixtures, longer tool life, ready machining of harder materials, and greater output with less work. Improved shop practices are also claimed to result from the use of carbide tools.

Colonial Alloys Company

Colonial Alloys Company and associated companies have issued data sheets on Colonial "V" plastics, which are made in three general types for numerous applications including tubing, pipe, monofilaments, multifilaments, rod, shapes, extrusions, sheets, tapes, injection moldings and compression moldings. Type 1 multifilament is suggested for weaving in cloth to specifications for glider fabrics and shrouds for weapon and supply parachutes. When made into rope, it may be suitable for barrage balloons and antennae balloons and for other applications such as tent and truck rope. Types 2 and 3 flexible tubing are suggested for tourniquets, oil or water or fuel lines, electrical insulation, radio shielding and for other places where rubber is generally used. When ends are sealed with heat and pressure, they may be suitable for life preservers.

Type 1 and 3 monofilaments are suggested for sutures woven into flexible fabrics, braids and tubing for surgical elastics and supports, for ankle and wrist bands, as sewing thread on balloon fabrics, and other uses. The data sheets give specifications and properties of the various types.



The American Foundry Equipment Company's new portable "Wheelabrator" for cleaning large and small miscellaneous products in a blast room without using compressed air. It will handle 70 lbs. of abrasive per min. at normal rated capacity.

Curtiss-Wright Corporation

G. W. Vaughan, President of Curtiss-Wright Corporation, has announced that a newly developed Curtiss military cargo transport airplane built of nonstrategic materials will be produced for the U.S. Army Air Forces in a new plant located in Kentucky.

The new military type, designated the Curtiss C-76 by the U.S. Army Air Forces, is to be built mainly of wood and other nonstrategic materials not on the Government priority list. A majority of its parts will be built in small assemblies by manufacturing organizations that have had experience in plywood construction.

While all details concerning the specifications and performance of the Curtiss C-76 are being withheld, Curtiss-Wright engineers say it will be approximately the size of transport airplanes now operated by the domestic airlines. A sketch of the new airplane, approved by the War Department for release, indicates that it is a twin-engined type.

While the major subcontracting organizations who will be associated with the project were not listed, it was indicated that a large number of companies are being considered, and a complete list will be made up soon. Many men with woodworking skill who would not previously have found a place in the aviation industry will be needed to produce the new aircraft.

E. I. du Pont de Nemours & Company

New plastic spacers are reported to save brass and steel and to speed up milling machine operations in the manufacture of airplanes, locomotives, electrical equipment, pneumatic and precision tools, and other goods. Plastic spacers are available in ten thicknesses, each with its own identifying color, intended to speed production by eliminating loss of time in measurements and in fitting and adjusting.

The spacers are made in thicknesses from 0.001 to 0.020 in. with hole diameters as high as 2 in. with standard keyways. Larger sizes with outside diameters up to 10 in. may be had on order. The spacers are said to retain their thickness and evenness under all normal working conditions.

Under the trade-marked name of "Artus Spacers," they are made by Industrial Products Suppliers from "Plastacele" cellulose acetate plastic produced by the Plastics Department of the du Pont Company.

Fisher Body Division General Motors Corporation

An employee training program of large scope is being conducted by Fisher Body to mobilize all its man power as quickly as possible for armament production.

In its automobile body building days Fisher dealt principally with sheet metal working, fabric for the interior of cars, painting of bodies and building tools and dies. Now it is engaged in a tremendous armament program. Instead of bodies the plants are building aircraft parts, tanks, artillery, tools, instruments and many small parts for other war goods.

Fisher Body's training program has been developed on two broad phases: first, job instruction of supervisors; and second, worker training. The job instruction training for supervisors has been highly developed into an intensive, full-time study program. Men chosen to act as instructors in this program are carefully picked for their knowledge and their ability to teach other men.

The goal in prejob training is to teach a worker one definite operation. There is no intent, for example, to turn out a fully qualified all-around machinist. Rather, the object would be to instruct a man in one phase of the machinist trade so that he could start to work immediately on at least one operation. Thus, the training is highly specialized and designed to fit a man into a production job as quickly as possible.

The Gaertner Scientific Corporation

The Gaertner 07-A-11 Automatic Oxygen Regulator is adapted to use with the continuous-flow type of mask and is suitable for use at altitudes above

25,000 ft. It is designed to regulate the supply of oxygen to a manifold line accommodating up to ten persons. It automatically controls the pressure in the manifold according to the altitude, maintaining a predetermined absolute pressure against a metering orifice installed at each delivery station into which the mask may be plugged. An improved flowmeter is also available for installation at this point if desired. The oxygen is supplied from cylinders varying in pressure from 1,800 lbs. per sq.in. when full, to 50 lbs. per sq.in. The regulator resembles the Army Air Corps type A-11, Specification No. X-40334, in performance.

The dial markings and pointers of the duplex gauge conform with Fig. 1 of Air Corps Specification No. 40319 of the Type A-9 Regulator. The flow indicator is responsive to the differential pressure between the supply manifold and atmospheric pressure and is calibrated in thousands of feet altitude.

General Electric Company

A new sensitive direct-current relay for aircraft service has been announced by the industrial control division of the General Electric Company. The relay, designated CR2791-C100C, is specially designed for use in vacuum-tube output circuits where the power available is so small as to require operation on extremely low current values.

A sealed aluminum cover protects the relay from dust and against damage from rough handling. The relay is small and light in weight, weighing only 3¼ oz., and is designed to meet all Air Corps requirements set up for devices of this type.

It has a maximum continuous current rating of 2 amp. at 32 volts, and a maximum make or break rating of 10 amps. The coil is rated at 32 milliwatts minimum and 1 watt maximum. Maximum coil resistance is 3,000 ohms. The contacts provide single-pole, double-throw operation.

A new switch specially designed for use in aircraft applications where space is limited and where vibration conditions are severe has been announced.

The switchette—believed to be the smallest switch of its type in the world—weighs only 9 Gm. and is designed to meet Air Corps requirements set up for devices of this type. It can be operated by lever, bellows or other actuating means by movement of a spring return button in the housing.

The contacts are arranged for single-pole normally open, single-pole normally closed, or single-pole double-throw operation. Each form is available with a contact air gap of 0.010, 0.020 or 0.030 in.

A new line of dynamotors for communication and other service in aircraft, tanks and mobile field equipment has also been announced. The new line of dynamotors comprises five types, ranging from 25 to 600 watts in output and from 3 to 31 lbs. in weight. Formex wire insulation, light weight and reliability under rigorous conditions are features. Each unit is designed for high output from a small frame size.

Objectionable alternating-current ripple is kept at a value which requires a minimum of filter to provide satisfactory operation of the communication equipment. The dynamotor commutators are carefully cut and undercut so that commutation will meet rigid standards.

The end caps are formed aluminum or steel covers which fasten to the end shields to keep dust and dirt out. End shields are of high-pressure cast aluminum or steel. Cartridge-type brush mechanisms are used, and brush holders are anchored in the castings. Capacitors are supplied across the brushes

WITH LIVES AND NATIONS AT STAKE . . . . . .

The partly unveiled unit shown above is a component part of Turbo-Supercharging Systems for use in high altitude planes. These highly efficient intercoolers perform vital air cooling functions both in the power plant and in the cabin.

fedders
MANUFACTURING CO., INC.

★ ★ ★ ★ ★ HEAT EXCHANGER DIVISION • BUFFALO, NEW YORK

when needed for suppression of radio interference, and brush springs are shunted with copper pigtails. Other features are: spiraled armature punchings to reduce noise and eliminate locking effect; carefully selected ball bearings with provision for lubrication and cleaning; and a stator formed from stainless steel tubing.

Walter Kidde & Company

To overcome the hazard to aircraft crews inherent in the possibility that oxygen tanks might explode and hurl jagged pieces of steel through the cabin if hit by bullets, the engineers of Walter Kidde & Company have developed oxygen cylinders said to be shatterproof even when hit by 0.50 caliber armor-piercing bullets. With gas pressure inside the cylinders as high as 1,800 lbs. per sq.in. the steel chunks could do more damage than bullets by injuring the men and riddling the airplane.

The new tanks can be pierced by bullets but they do not burst, due to their ingenious design which has resulted in only a slight increase in weight. The latter is an important factor, since a modern airplane must carry from two to ten oxygen tanks for long flights and weight must be kept at a minimum to provide for adequate fuel and bomb loads.

The Lincoln Electric Company

Increased speed of welding through use of larger diameter electrodes is advocated by The Lincoln Electric Company to speed war production. J. F. Lincoln, President of the company, said that welding work which now takes eight hours could be done in six by simply employing $^1/_4$ in. diameter electrodes in place of $^5/_{16}$ in. In addition, Lincoln said that 25,000 welding operators would be made immediately available for other or additional work if a size larger electrode were adopted by half the war-production welders on just half of the work now being welded.

Littelfuse Incorporated

A line of fuse panels designated as Universal Fuse Panel No. 1505 is being offered by Littelfuse Incorporated to save time in engineering, drafting and production. These rugged, lightweight fuse panels are equipped with terminals and beryllium copper clips or terminal studs and are ready for mounting. They are said to meet Air Corps requirements.

Metallizing Engineering Company, Inc.

Metallizing Engineering Company, Inc., has introduced a metallizing process and equipment for its application. The system enables essential industries to eliminate replacements and increase the service life of equipment now difficult to replace by building up worn parts of machinery with sprayed metal having the desired qualities of resistance to wear and corrosion. Metallizing is also used to salvage mismachined parts and defective castings. Metallized "inserts" and coatings are helping manufacturers to conserve vital metals.

National Association of Manufacturers

Under the leadership of Charles E. Wilson, President of the General Electric Company, a number of the nation's important executives have formed themselves into a Speakers Committee. Their purpose is to inform the American people of the achievements, failures, plans and problems of American war factories—insofar as it is possible without divulging information of value to the enemy—and to keep the public advised of industry's plans for meeting postwar problems.

Operating through the Speakers Bureau of the National Association of Manufacturers, these industrialists are now offering their services as speakers before serious-minded gatherings of their fellow citizens who desire information about the industrial production aspects of the war effort and related social and economic topics.

Convention chairmen and program chairmen are encouraged to write to the Speakers Bureau of the National Association of Manufacturers informing the Bureau of their convention dates, the interests of their meeting and the size of the audience expected. The Bureau will be glad to suggest the names of two or three industrial leaders whose activities and interests are closely related to those of the group to be addressed.

Also under the auspices of the N.A.M. Speakers Committee is a small group of staff speakers whose services are also obtainable through the Speakers Bureau. These men, through intimate contact with the nation's leading war-goods manufacturers, are able to present up-to-the-minute information on almost any aspect of industrial war output, as well as on various social and economic topics intimately related to the war production effort, and on industry's postwar plans.

Ohmite Manufacturing Company

A 16-page catalogue listing over 1,000 stock items in rheostats, resistors, tap switches, chokes and attenuators has been issued by the Ohmite Manufacturing Company.

This new catalogue is useful to engineers and purchasing departments as a quick-reference specification or buying guide. It gives illustrations, descriptions, ratings, prices and other helpful information on the wide range of Ohmite stock types and sizes and simplifies selection. There are close-control vitreous enameled rheostats ranging from 25 to 1,000 watts, Dividohm adjustable resistors from 10 to 200 watts, and fixed resistors from 1 to 200 watts, all in many resistance values. Two types of tap switches and a wide variety of power line and R.F. plate chokes are listed. There are also many other items of general interest.

Pulmosan Safety Equipment Corporation

Pulmosan Safety Equipment Corporation has developed "Magout" powder to extinguish magnesium fires. It is said that this powder instantly smothers fires caused by magnesium shavings in machine shops or by magnesium incendiary bombs. It is nonabsorbent, finely pulverized dry powder, safe to handle and easy to use.

Magout is available either in bulk quantities or in handy, instant-action tubes for sprinkling on fires. This is a new type cardboard container, spiral shaped for convenience in handling, with metallic ends and lined with paraffin.

Seamless Steel Tube Institute

Seamless tubes of alloy steel form certain vital parts of the Lockheed interceptor airplanes now being manufactured both in this country and in Great Britain. In the plant of the Menasco Manufacturing Company, heat-treatment of the tubes is done in four cylindric furnaces for hardening and drawing and in an oil quench tank arranged for water cooling. Both the furnaces and the gas converters that supply them with a controlled atmosphere are General Electric products.

The tubes are racked in a carrier that, in combination with a high-speed hoist, facilitates rapid handling. To avoid excessive cooling of the thin-walled tube in transferring the charge from the furnaces to the quench tank, two quenching hoods are employed. When the charge is up to required temperature, a hoist with a transfer hood is brought over the furnace and the charge is quickly placed in it. Then the hood is shifted, with the charge, to a point over the quench tank and the charge is dropped quickly into the quench. The purpose of the hood is to minimize cooling, warpage and scaling of the tubing.

Society of Automotive Engineers

Additional aeronautical standards and aeronautical recommended practices have been issued by the Society of

Automotive Engineers as follows: AS 29—Ignition Shielding, Aircraft; ARP 57—Carburetor Envelope, Aircraft—Size 48; ARP 58—Carburetor Envelope, Aircraft—Size 58; ARP 59—Carburetor Envelope, Aircraft—Size 78; ARP 60—Carburetor Envelope, Aircraft—Size 100; AS 84—Splines, Involute.

A revised index has also been issued, including these new listings, and further standards and recommended practices are in course of preparation.

United Air Lines

All twelve directors of United Air Lines were re-elected at the company's annual meeting at Chicago.

The Directors are Martin C. Ansorge and Joseph P. Ripley, New York; Governor Sumner Sewall, Augusta, Me.; Frank W. Fuller, Jr., San Francisco; Justin Dart, Boston; and Lester Armour, Mark W. Cresap, W. A. Patterson, John J. Mitchell, J. A. Herlihy, Paul M. Godehn and Robert M. Roloson, Jr., all of Chicago.

At a subsequent meeting of the Board, W. A. Patterson was re-elected President; J. A. Herlihy, Executive Vice-President in charge of operations; S. V. Hall, Vice-President, western operations; R. E. Pfennig, Vice-President, eastern operations; Harold Crary, Vice-President in charge of traffic; C. C. Thompson, Vice-President; N. B. Haley, Treasurer; and P. M. Willcox, Secretary.

Wright Aeronautical Corporation

Development of a forged cylinder head, together with methods for producing it speedily in large quantities, has been announced by Wright Aeronautical Corporation. The new head is said to allow a 12 to 15 per cent increase in the power output of an engine without increase in weight.

It is stated that in addition to its bearing on combat performance the forged-head development has an important effect on the war production of aircraft engines. Revolutionary manufacturing techniques speed up the fabrication of heads, conserve man-hours by effecting a 40 per cent saving in material rejections and release drop hammers and foundry equipment for the work of turning out other parts.

The forged-head technique is said to achieve an ideal sought by the aviation industry since its inception—that is, a service engine weighing less than 1 lb. per hp. The strength of the new heads permits higher compression ratios and increased power output per cylinder without increase in weight. In tests, the forged heads have withstood hydraulic pressures double the maximum for cast cylinder heads now in general use.

The new Wright forged cylinder head and the rough stock from which it is made. The new head allows a 12 to 15 per cent increase in power output of an engine without increase in weight.

In fabricating the forging, aluminum bar stock is extruded and emerges roughly in the shape of the desired forging. Sections of the extruded bar are pressed in a die to final shape. Nine separate drop hammer operations are eliminated by adaptation of the extrusion-die process to the forged cylinder heads, thus leaving drop hammers free for other uses in the war production program. On the forged heads the fins are cut by high-speed milling machines that permit closer finning and better cooling. Cooling is further improved by a 35 per cent increase in the conductivity of the metal. The forged-head technique allows the enlargement and improvement of intake and exhaust ports, contributing not only to increased engine output but to decreased fuel consumption and extension of range.

The final solution of the production problem was achieved by the development of machines for cutting the fins. The forged-head manufacturing method developed by Wright Aeronautical can now be adopted as standard by all other aircraft engine manufacturers.

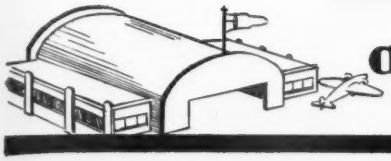
Details of a plan for salvaging thousands of tons of vital scrap from steel aluminum and other high-grade materials used to manufacture Wright aircraft engines, in such a condition that these materials can quickly be reapplied to the war effort, were announced by G. W. Vaughan, President of Wright Aeronautical Corporation.

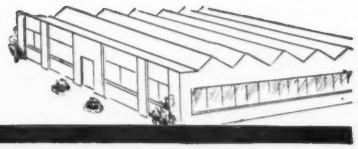
This system, evolved by the company in the last few months for sending salvaged metal to steel companies, shipyards and tank manufacturers, as well as to smelters for reprocessing for the aeronautical industries, has the advantage of segregating the various metals as fast as they are removed from forging and casting by lathe, drill or milling machines. Basically, the plan is directed at separating and saving metals as fast as they are removed by machining processes. Machine tools ranging from small boring machines to massive turret lathes have bins attached which catch and hold all shavings and chips or whatever waste is produced by that machine tool. Since Wright is now employing "in-line" production methods, whereby a machine tool is used for one specific job only, such a tool always produces the same kind of scrap.

Salvage collectors wheel large boxes up and down the factory aisles, gathering a special type of metal. To be sure there is no mixing, the containers are identified with the machine tools by a foolproof color-marking system. Although steel, aluminum and magnesium are the principal metals salvaged, the list also includes copper, beryllium bronze, phosphor bronze, aluminum bronze, brass and a variety of others.

Wright Aeronautical also saves and utilizes such things as cutting oil, paint pails, 5-gallon tins, empty oil drums, old rags, burlap bags, cardboard and paper, used files, old grinding wheels, barrels, broken and worn tools and nail kegs. Waste paper, cardboard and old rags are salvaged at the rate of 2 tons or more per day.

House Organs and Catalogues





Welding Techniques

As a means of reviewing the several oxyacetylene-flame and electric-arc processes that are particularly helpful in accelerating the tempo of aircraft production, Air Reduction Company of N.Y. has prepared a 16-page booklet entitled *Airco in Aviation.*

Oxyacetylene cutting, a fast and accurate means of shaping steel, is discussed in the light of its ability to speed up and simplify production procedures. Reference is also made to production welding, the welding of jigs and fixtures, flame hardening, low temperature brazing, flame cleaning and various other metalworking techniques.

The last section of *Airco in Aviation* describes the engineering assistance that the manufacturer offers the aeronautical industry to get best results from the use of the company's products and processes. An important phase of this service is a series of six books prepared to provide a program for the training of welding and cutting operators. These lecture and instruction books are illustrated and briefly described. *Air Reduction Company.*

Blade Repairs

Blade Straightening Saves Time and Material in All-Out U.S. War Effort. Methods followed in repairing and straightening damaged blades returned to the Hamilton Standard Propeller Plant are described briefly in this article, which shows that even propeller blades that have been torn and pierced by bullets can be restored to serviceable condition. This work goes a long way toward conserving scrap materials, especially in cases where propellers of training aircraft are damaged. *The Bee-Hive,* March–April.

Valiant Fighters

"Wildcats" Valiant in Pacific Combat. Although few details were revealed, it was indicated that the Grumman Wildcat powered by Pratt & Whitney engines gave an excellent account of itself against the Japanese when American forces attacked the Marshall Islands. A squadron of Grumman fighters operating from an aircraft carrier formed the spearhead of the attack operating against strongly fortified land positions, and they also provided air cover for the United States naval craft. In the action around Gilbert Island and Wake Island, Grumman fighters also took a prominent part. *The Bee-Hive,* March–April.

Waterproof Covering

New Method of P & W Engine Packing. A new method has been developed by Pratt & Whitney for packing airplane engines in an envelope of pliofilm to keep them dry inside and out, lengthen the period of safe storage and eliminate the need of covering the outside metal parts with protective grease before shipment. The engine is placed inside the pliofilm envelope, inside of which are placed several small dehydrating bags to absorb moisture surrounding the engine. Special Protek-Plugs containing dehydrating crystals are inserted in the spark-plug openings to absorb moisture inside the cylinders. A humidity indicator card is also placed inside the envelope permitting easy inspection of the relative humidity inside the enclosure. The bag is then closed and vulcanized, and the completed engine inside the bag is placed in its packing case. Engine parts are also packed in pliofilm-lined cartons. *The Bee-Hive,* March–April.

Felt Manufacture

The Technique of Felt Making. The characteristics of felt, its applications and the processes used in its manufacture are described and illustrated in a catalogue issued by The Booth Felt Company, which also tells of the raw materials, the sources of supply and the importance of the product to industry. Precision-cut mechanical felt parts and their properties and uses are detailed. Felt seals for bearing housings are shown in drawings, and the felt specifications of the A.T.S.M. and of the S.A.E. are reproduced. *The Booth Felt Company,* Brooklyn, N.Y.

Monel in Aircraft

Tremendous Trifles That Keep 'Em Flying. An examination of the many places in the modern military airplane where special parts made of Monel metal contribute to the superior performance of American combat and bombing aircraft. The alloy's resistance to vibration makes it useful for primer tubing. Its imperviousness to spark erosion fits it for application in magnetos, distributors and other parts of the ignition system, while its resistance to corrosion, its ability to transfer heat rapidly while resisting heat deterioration, and its nonmagnetic qualities make it useful in other directions. All of these characteristics and their direct application in airplane building and maintenance are outlined. *Mechanical Topics,* April.

Historical Background

Big Doings in the Smallest City. The little city of Vergennes, Vt., is again giving its talents to the production of war materials. Said to be the smallest city in the United States, Vergennes was doing its part 130 years ago by contributing, among other things, the casting of 177 tons of cannon shot, and one of its important plants is now busy turning out aircraft control equipment.

The Simmonds-Benton Manufacturing Division of Simmonds Aerocessories, Inc., has been operating on the banks of the Otto River since 1906 and is still taking power from the river which for many years has supplied power to this active industrial town. The plant is now being expanded to handle an increasing volume of work for the current war effort. *Simmonds-Benton Manufacturing Division of Simmonds Aerocessories, Inc.*

Stamping Machine Catalogue

A catalogue describing the Cecostamp impact-type stamping machine developed for forming thin sheet stock, such as aluminum alloys used in aircraft construction. The brochure describes the construction and operation of the press, indicates its many features and demonstrates how they can be applied to the short-run production schedules of aircraft production. *Chambersburg Engineering Company,* Chambersburg, Pa.

Engine Applications

Newly released by the Lycoming Division of The Aviation Corporation

THE *Split Shell* ...pioneered on

CANNON PLUGS

The highly practical split shell for electrical connectors is an original development of Cannon Electric and is now universally used. It is only one of many improvements we have made for aircraft electrical systems to reduce weight and save time.

Cannon Plugs have many other equally important advantages. That's why they are standard equipment in aviation, radio, television, submarines, geophysical research and many other fields where quick assembly, precision and absolute dependability are required.

MAKES POSSIBLE USE OF SHORT CABLES—SAVES WEIGHT
When shells are removed conduit can be slid back over the cable at either end, making room to solder or rearrange connections without having slack in the cable.

CANNON ELECTRIC
DEVELOPMENT COMPANY
LOS ANGELES • CALIFORNIA

is a comprehensive folder giving flight views of the numerous types of Lycoming-powered training airplanes used in Army and Navy pilot training and in civilian instruction. These include light planes such as Aeronca, Funk, Piper, Taylorcraft and Skyfarer; military primary trainers of the Stearman, Spartan and Morrow types; the Stinson L-49 and Beechcraft, Cessna and Curtiss bimotored transitional trainers.

Part of the new literature is devoted to photographs and brief descriptive matter on the various series of Lycoming engines, the 220- to 300-hp. radials, the six-cylinder 150- and 175-hp. horizontally opposed engines, the four-cylinder 100- and 125-hp. horizontally opposed engines, the four-cylinder geared 75-hp. engine and the four-cylinder 50- to 65-hp. engines.

Oxygen Equipment

Descriptions of the equipment manufactured by The Ohio Chemical & Mfg. Co. to combat the effects of anoxemia resulting from the diminution of barometric pressure in flight. The catalogue contains structural and operational details on various types of rebreather masks, oxygen lines, regulator valves, tanks, flow indicators and complete portable units. Such tables as the rates of flow required at various altitudes, lengths of time various cylinders will supply oxygen to one person, capacities and similar figures are also supplied. Cross-sectional drawings of the components that comprise the Ohio aviation equipment giving names and order numbers are also provided. *The Ohio Chemical and Mfg. Co.*, Cleveland, O.

Regreasing Device

Recent Production Boosters. Perry Anderson. In high-altitude operation it was discovered that the grease in standard aircraft roller bearings became too viscous to permit free operation. This necessitated the removal of the standard grease and its replacement by a less dense lubricant. The article describes the method by which the old grease was removed and the adaptation of a standard Alemite grease gun for the rapid regreasing of the bearings on a mass production basis. *The Fleetwings Arrow*, May.

Financial Statistics

Looking Up With Aviation in 1941. K. W. Tibbitts. The third annual survey of the revenues and finances of aircraft manufacturers and air transportation companies in the United States presents analyses and combined financial statements of various groups of companies said to transact about 90 per cent of the business of the industry. The information is classified under manufacturers of military aircraft,

manufacturers of sport airplanes and commercial airlines for the year 1940, and comparisons are made with preceding years. *National Credit Office, Inc.*, New York.

Aircraft Maintenance

100% Is Passing. Maintenance work of such an exacting character that an expert has difficulty in distinguishing between a nearly new transport airplane and one that has been used for years is described at considerable length. The routine and schedules are traced through the daily inspections and fixed service operations performed at definite intervals based on hours and miles, emphasizing the painstaking thoroughness that must prevail. Not only are the necessary repairs made but replacements and additions of new parts and equipment are keeping pace with the latest designs so that the aircraft does not wear out or become obsolete. The processes have been so improved that a complete overhaul that formerly required 72 hours is now finished in 24 hours. Illustrations show some of the work and equipment employed. *Trade Winds*, April.

Training Program

The National Aeronautic Association announces an aviation education program designed to supplement the federal courses now in preparation and expedite the teaching of aviation subjects in the public schools.

To round out the air training system, the N.A.A. has set up the following program: organization of Air Youth Sponsoring Committees in each community to work for the establishment of aviation classes in the schools and the creation of Junior Air Reserve Flights and Squadrons in which air-minded boys of premilitary age will secure elementary training in aviation for defense purposes; encouragement of airplane model clubs under the Academy of Model Aeronautics; development of aviation-education materials including books, pamphlets, charts, motion pictures and radio programs; establishment of a club program service for schools and local clubs; and active cooperation with service organizations desiring to participate in the national aviation education program.

Assistant Secretary of Commerce for Air, Hinckley, has stated that a successful school program will need the combined efforts of the federal agencies and the National Aeronautic Association. Gill Robb Wilson, N.A.A. president and member of the Joint Advisory Committee's executive group, has already pledged the association's full aid in the new program. *National Aeronautic Association.*

A Greenlee automatic cylinder head transfer machine. This machine is 154 ft. in length and combines the operations of 39 older type machines. Pictured here are cast cylinder heads being machined.

Ground Crew Service

Ready for Action, Sir! Don Howard. The routine work of an Army Air Corps ground crew is presented in a narrative which traces the action from the time a returning bomber circles in for a landing until it is ready for the next take-off. Alert, thoroughly trained service men spring into rapid, precise action, each one giving expert attention to his particular task in restoring the airplane to peak efficiency. Supplying fuel and lubricants, examining tires, instruments and controls, checking all functions of the engines and propellers and performing any needed repairs calls for the services of 18 men on the ground for every one in the air. The importance of such painstaking service work is emphasized, and reasons are given for the application of similar thoroughness and efficiency to the service rendered by automobile service stations for the nation's motorists. *Shell Progress*, April.

Oil from the Open Places

Louisiana Producing. Narrating in pictures and captions some of the activities of producing, storing and transporting petroleum in the delta of the Mississippi, this article shows how oil is located and wells are drilled, sometimes under water, and how the pipe lines and storage tanks are maintained. Engineers, executives and workmen travel over the vast distances of the territory in airplanes owned by the company, in boats and on foot in the performance of their duties. *The Texaco Star*, April.

Hose Clamps

Wittek Manufacturing Company has issued a new condensed catalogue describing the Wittek Type FB hose clamp for aircraft use and for other applications where a solid band, stainless steel clamp is essential for a permanent, leakproof hose connection. It contains specifications, illustrations and descriptions on this and other types of Wittek hose clamps especially adaptable to the aircraft industry. *Wittek Manufacturing Company*, Chicago, Ill.

Paratroop Training

I Wanted to Jump from a Plane. Steward W. Smith. A paratrooper describes the preflight training and conditioning given to prospective parachute soldiers by the Army and how it feels actually to perform a parachute descent. The fighting courses that the men must take in the handling of pistols, rifles, mortars, antitank guns and other weapons are also described. *Douglas Airview*, April.

Meterologists Wanted

War Effort Exposes National Shortages of Trained Meteorologists. Gerald D. Barton. Attention is directed in this article to the need for trained meteorologists in the Government civil service, in the airlines and in the Army Air Corps Technical Training Command. The services performed by these scientists are outlined in connection with war operations and civilian flying activities, and postwar opportunities are sketched. *Spartan News*, April.

Service School

College of Engines. The history and work of the Wright Aeronautical Corporation Service School are traced from its establishment in 1938 with only one instructor and a classroom in a corner of the engine-overhaul shop to its present 7,000 sq.ft. of floor space, complete equipment and more than 600 students per year. Courses and lectures are given to experienced mechanics and engineers from the airlines and manufacturing companies and to Army and Navy maintenance personnel. The scope of the work is outlined. *Trade Winds*, April.

Suggestion Plan

More than 2,700 entries have been received from the employees of the three plants of North American Aviation in the production-idea contest sponsored by the company. Of the total, 1,170 suggestions were submitted by personnel of the main plant at Inglewood, while 807 ideas came from Dallas and 730 from Kansas City. Virtually every department at Inglewood was represented, led by the inspection group with 117 ideas. Judges are busy considering the entries, and awards will soon be announced of the 140 individual prizes in the $10,000 contest. *North American Skywriter*, April 24.

Dear Pop:

Even an old Rainbow Divisioner like you would pop your eyes at the army we're putting together this time. Let me tell you, they're doing everything to make up just about the best bunch of fighting galoots you ever saw.

And that goes for what they do for us off duty, too! Take this new clubhouse we got just outside of camp. It's got radios, dance floors, nice soft chairs and everything. And, Pop, you can get something to eat that won't cost you a month's pay!

Now, the army isn't running this. The USO is. And most of the other camps got USO clubs too, because you and a lot of other folks dug down and gave the money to the USO last year.

But, Pop, you know what's happened since then. Guys've been streaming into uniform. Last year there was less than 2 million of us. This year there'll be 4 million. And the USO needs a lot more dough to serve that many men—around 32,000,000 bucks I hear.

Now, Pop, I know you upped with what you could last time. But it would sure be swell if you could dig into the old sock again. Maybe you could get some of the other folks in the neighborhood steamed up, too.

It will mean an awful lot to the fellows in camp all over the country. Sort of show 'em the home-folks are backing them up. And, Pop, an old soldier like you knows that's a mighty nice feeling for a fellow to have. See what you can do, huh, Pop?

Bill

GIVE TO THE

USO

Send your contribution to your local USO Committee or to National Headquarters, USO, Empire State Building, New York, N. Y.

THIS SPACE CONTRIBUTED BY THE BG CORPORATION

Institute News

Growth of Our Publications

The change of "Institute Notes" from the JOURNAL OF THE AERONAUTICAL SCIENCES to this department in the AERONAUTICAL ENGINEERING REVIEW is but one step in a move to make the Institute publications of greater usefulness and value to members and subscribers.

The change in name of the AERONAUTICAL ENGINEERING REVIEW signalizes also an enlargement in scope of its publication policy. Its coverage of aviation news, new books, digests of periodical articles, and industry and government publications will be continued and made more complete. In addition, more articles on applied engineering, aeronautical production problems and reviews of developments in various aeronautical fields will be published in forthcoming issues. The heartening response from members, subscribers and advertisers received by the REVIEW over the past year and a half since it was established now enables it to increase its service to them.

Another immediate result will be to provide more space in the JOURNAL for the publication of full length technical reports.

As everyone connected with aviation in America today knows, speed is of the essence in the success of our national war effort. The JOURNAL's responsibility in disseminating technical information in a field vitally important to this effort lies not only in making scientific papers available for the people who should have them but in doing so quickly. There must be as little time lag as possible between the completion of a report on some research work of value to the aeronautical profession and the date of its publication. The limitations on space for papers is, of course, one that is imposed by costs and the funds obtainable to meet them. The Institute is resolved to use all resources available for more prompt publication of papers accepted. Its membership and the support received from the aeronautical industry and profession are increasing steadily, but the demand for its services increases even faster and with greater urgency. The Institute is prepared to give that additional service now, believing that the improvements made will bring increased support from the industry and from enlarged membership that is deserved and necessary to continue it.

The Institute's two magazines now provide a means for the publication of papers in all technical and engineering phases of aeronautics, and authors are invited to submit papers to be considered by the Editorial Board for publication either in the JOURNAL or REVIEW. At the time that such papers are reviewed for publication, consideration also will be given to their possible presentation as lectures before meetings of local Sections and Student Branches. Authors may be assured that their contributions will, as in the past, be carefully read by Editorial Board members eminently qualified in their fields and that prompt notification will be given as to the acceptance of papers.

Because of their select circulation among Institute members and others in companies, institutions and Government bureaus concerned with aviation, papers appearing in the JOURNAL and REVIEW reach the most important group of readers in the aeronautical profession. These readers are familiar with the high standards of the Institute's publications and give particular attention to the articles that are printed in them.

Changes in Membership Qualifications

At the last meeting of the Council of the Institute the various grades of membership were discussed, particularly in view of the changes in the past year in the aeronautical industry and the qualifications of engineers who have recently taken up aeronautical work.

Through necessary amendments to the By-Laws, certain changes in qualifications were made to meet new conditions and enable the Institute better to serve the rapidly growing aeronautical profession.

The qualifications for Associate Fellow remain as before according to the following as quoted from Article I of the By-Laws:

"*Section 5.* Associate Fellows shall have been members for six months or more and ordinarily be over thirty years of age. They shall have been personally responsible for important aeronautical developments. They shall have been actively engaged for a minimum of five years in aeronautical engineering, research, instruction or the application of science to aeronautics, or they shall have attained an equivalent position in work closely allied to aeronautics or in the aeronautical arts and literature. Applicants for this grade shall be recommended by four members of the Institute, two of whom must be Fellows or Associate Fellows."

Members wishing to be transferred to this grade should make application on the regular application form. There are many members of the Institute who are undoubtedly qualified for the grade of Associate Fellow, and the Council invites those who have such qualifications to apply in order that the grading of Institute members may reflect more accurately their professional standing.

The requirements for the grade of MEMBER have been amended by adding the last sentence to Section 6, which reads in full as follows:

"*Section 6.* MEMBERS shall ordinarily be over twenty-five years of age and shall be persons who have completed approved courses in engineering and in addition have been engaged in aeronautical work for at least three years; or they shall be persons who have been engaged for at least five years and acquired a recognized standing in aeronautical engineering, design, research, instruction, test flying, the application of special sciences to aeronautics, or the technical development of the manufacture or operation of aircraft, aircraft engines or other essential

U.S.-Built Bomber Crosses Atlantic in 400 Minutes

—*Aviation, May, 1942*

A civilian ferry pilot flying an American bomber to England recently got on a tail wind and made the trip in 6 hr. 40 min., clipping an hour from the previous record.

The distance is about 2,400 miles; average speed about 330 mph. After setting the mark, with a Consolidated *Liberator*, the pilot still had too much gasoline for safe landing and he was compelled to circle the field for three hours to lighten his load.

It is against the rules for ferry pilots to speed on crossings and violations are punished, but the pilot in this case convinced authorities that his speed was accidental.

The rule against speed is to keep restless pilots from using up their engines by running them too wide out.

THAT'S *Performance Predictability!*

THIS actual news-story, reproduced above, underscores one of many recent achievements of modern aircraft injection carburetion . . . an advancement developed in Bendix research laboratories.

Stromberg Aircraft Injection Carburetion has definitely improved fuel economy. Thus, greater flying range and increased load capacity are attained. And so consistent is the rate of fuel consumption that the pilot is safely justified in remarkably close calculations of a ship's flying-range.

Other attributes of this modern carburetion are: automatic continuous self-adjustment to proper fuel-air mixture for all altitudes, employing fixed-size metering jets; simplification of field service work because virtually identical basic design is employed in the carburetors used on various engine makes and models.

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components or accessories of aircraft. Previous scientific or engineering experience in some non-aeronautical field may be considered as part of the qualification of an applicant for this grade provided it is shown that this experience has contributed to the aeronautical work being done at the time of application."

The addition of this last sentence recognizes the fact that many engineers highly proficient and experienced in other fields have recently engaged in aeronautical work; thus, their experience, which has contributed to their present responsibility and value in the aeronautical profession, is recognized in their grading as full MEMBERS.

A few changes have been made in the wording of the requirements for Industrial Member, which now reads as follows:

"*Section 7.* Industrial Members shall ordinarily be over twenty-five years of age and shall be persons engaged in the application or development of aeronautics in an administrative or supervisory capacity who have acquired a recognized standing in the aeronautical industry."

This grade gives recognition to men of experience in aviation whose chief functions are now in an executive capacity in aeronautical production and operations.

The requirements for Technical Member have been changed to read as follows:

"*Section 8.* Technical Members shall be former Student Members who have graduated and those persons engaged in scientific or engineering work in aeronautics or fields closely related to aeronautics. The records of any who have been members in this grade for over one year and who are over thirty years of age shall become subject to review by the Council for transfer of such members to the grade of MEMBER or Industrial Member."

This grade still serves the original purpose for which it was provided by the Institute several years ago in making available membership and the services of the Institute at a lower rate of dues to young men who have just begun their careers in aeronautical work. It is now limited more specifically to those who have qualifications and some experience in the scientific and engineering phases of aeronautics since it is this phase with which the Institute is most directly concerned. In this grade there are now many members who are qualified for the higher grade of Industrial Member, MEMBER or, in some cases, even Associate Fellow. It is again urged that those qualified apply to the Admissions Committee for transfer to a more suitable grade of membership.

In order that the Institute might make available certain of its services to a large number of people engaged in aeronautical work and interested in the activities of the Institute but not qualified for membership in any of the abovementioned grades, the Council decided to create a grade known as Affiliates to which applicants will be admitted under the following provision:

"*Section 9.* Affiliates shall be persons who are engaged in aeronautical work or work related to aeronautics who wish to participate in the activities of the Institute and receive the services specified by the Council for this grade of membership."

Affiliates will pay $5.00 annual membership dues, for which they will receive the AERONAUTICAL ENGINEERING REVIEW and will be permitted to attend Section and national meetings of the Institute. Those Affiliates who wish to do so may receive both the JOURNAL OF THE AERONAUTICAL SCIENCES and the REVIEW by paying dues of $12.50. It is believed that the Institute will thus be able to render a greater service that is needed by a large section of the personnel of the aircraft industry without affecting the qualifications or lowering the standards of its other grades of membership. In time, quite a number of those admitted as Affiliates may, through experience accumulated in some technical phase of aviation work, become qualified for other grades of membership.

The Council invites and urges all members of the Institute, first, to consider whether their own grade of membership still represents their standing in the aeronautical profession and, if not, to apply for a change of grade; and, second, to invite those of their colleagues and acquaintances in aviation work who are not members of the Institute to apply for membership and explain to them the revised qualifications and the services rendered.

Sections and Branches

Detroit Section

The meeting on May 6 was restricted to Institute members and a few guests. A motion-picture film furnished by Pan American Airways was shown. The subject of the meeting was a discussion on air transport which was led by Professor George Tweney of the University of Detroit, formerly a member of the engineering staff of Pan American Airways. It was announced that the next meeting of the Section would be devoted to a discussion of propellers.

The Aeronautical University

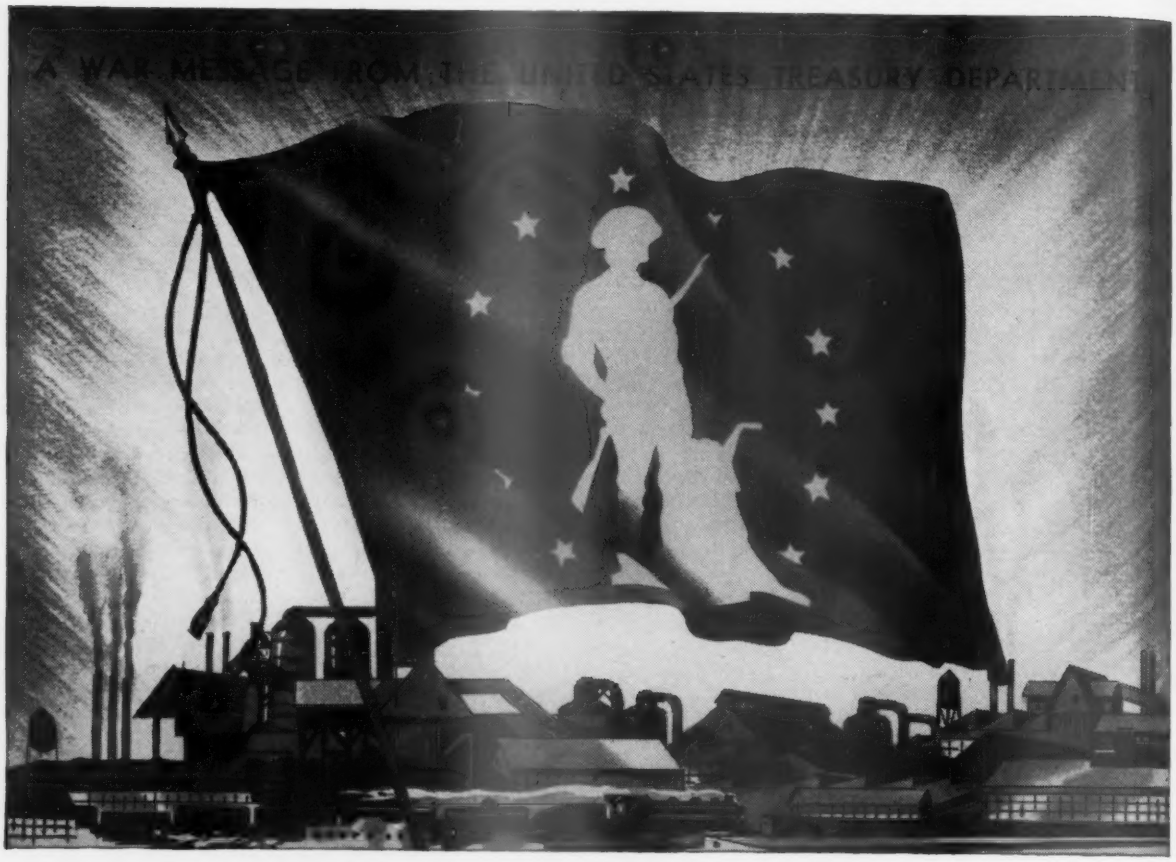
Activities of the Branch for the semester just passed culminated with the banquet held at the Aviation Post Room, Sherman Hotel, Chicago, on March 31. Sixty-eight members of the Branch, the faculty of the University and their guests attended. Marvin Bley, acting as toastmaster, introduced Herbert W. Reed, Honorary Chairman, who spoke on the future plans for the Institute and the Midwest Student Sectional Meeting for 1943, for which the Aeronautical University has offered its facilities. Dean Simms of the Engineering School and L. M. Churbuck, President of the University, addressed the gathering. The main speaker of the evening was Dr. Horace R. Byers, Professor of Meteorology at the University of Chicago, who spoke on "Weather in the War." Miles Mraz presented University keys to the retiring Branch officers—Raymond Young, Marvin Bley and Robert Beeson. The program concluded with the showing of motion pictures in color describing the aviation training program of the Board of Education.

At the meeting held on April 7 a resolution was passed amending the By-Laws of the Branch to require that students must maintain a B average in all engineering subjects in order to remain Student Members of the Branch and Institute. Officers for the new semester were elected as follows: Chairman—Charles H. Brunell; Vice-Chairman—William Pinsly; Secretary and Treasurer—Narcyz M. Wasilkowski; Honorary Chairman and Faculty Adviser—Herbert W. Reed. A rising vote of thanks was extended to the retiring officers. New members were initiated into the Branch at its meeting on April 21 and plans were made for the next regular meeting in May.

Agricultural & Mechanical College of Texas

On March 26 the Branch held a joint meeting with the Student Chapter of the A.S.M.E. Dr. John E. Younger spoke on experiments carried out on pressurized aircraft cabins at Wright Field. A film on the Sikorsky Helicopter was also shown.

The I.Ae.S. Student Branch took active part in the Engineers' Day held at Texas A. & M. on April 4. Members explained to visitors the exhibits in the Aeronautical Engineering Department which were open to the public. They consisted of displays of the drafting room, engines and their operation, the wind tunnel, fuselage construction of the PT-9 and a Meyers Trainer, a constant-speed propeller and an exhibit on the construction of wings and the theory



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of lift. Navigation and meteorologic instruments were also displayed.

Alabama Polytechnic Institute

New officers for the Branch elected on March 24 are: Chairman—G. Jack Tankersley; Vice-Chairman—Victor C. Hicks; Secretary-Treasurer—Edward A. Wagner. The Branch members took charge of the aeronautical engineering shops on Engineers' Day at Auburn on March 25. They conducted lecture tours through the shops and presented an exhibit on light airplane construction.

University of Alabama

Prof. Leslie A. Walker, recently elected Honorary Chairman and faculty adviser of the Branch, spoke briefly at a meeting on April 6. A paper on "Plywoods in Aircraft" was presented by Angelo Conti as his entry in the competition for the Student Branch Lecture Award. Albert Gurney presented a paper on "Superchargers" at a meeting on April 17. At this meeting plans were made for the forthcoming annual picnic and election of officers for next year.

Boeing School of Aeronautics

Student officers for the next term were elected at a meeting on May 9 as follows: Chairman—Jack Gilberti; Vice-Chairman—Richard Fayram; Secretary-Treasurer—Curtis Dunwoody. Since Dr. Maurice Garbell, who had been acting as Honorary Chairman and faculty adviser, had recently left the Boeing School, Mortimer Powell was elected Honorary Chairman in his place.

University of California

At a recent joint dinner and meeting with University A.S.M.E. members, the I.Ae.S. Student Branch heard Dr. John E. Younger speak on the subject "Building Tomorrow's Airplane—Today." New Branch officers elected are: Chairman—Andrew Marshall; Vice-Chairman—Martin Forbes; Secretary-Treasurer—Robert Lockhart.

Harvard University

The new Branch officers elected in March arranged a series of four lecture meetings. Lectures on "Elementary Hydromechanics" were presented by Branch members—H. P. Sorensen on April 8 and B. F. Shattuck on April 15. On April 29, Prof. Richard von Mises spoke on "Complex Numbers and Their Use." The last meeting of the school year was held on April 29, at which Dr. Willy Prager of Brown University presented "An Introduction to the Theory of Plasticity."

Indiana Technical College

At a meeting on April 13, Stanley Rasciz gave a report on the Rolls-Royce Merlin XX aircraft engine; Everitt V. Swenson, a former employee of Bell Aircraft Corp., read a paper on lofting; and a paper on reversible pitch propellers for multiengined flying boats was presented by Ray G. Trout. Prof. George Schultz (Lt., U.S.N., Retired), the guest speaker of the evening, gave a talk on his experiences at Annapolis, Pensacola and aboard the aircraft carrier "Lexington." After a short recess motion pictures were shown.

At a meeting on May 4 the recently appointed Alumni Committee reported on a letter from George Rice, '38, former aeronautical engineering student who is now working for Lockheed in England. The Branch voted to present a propeller clock as a farewell gift to Prof. James Ross, who is leaving the Aeronautical Department of Indiana Technical College. A paper on the comparative advantages of radial and inline aircraft engines was presented by Bennett Kemp, who was formerly employed in the crankshaft division of the Ford Motor Company. Ray Pothoff gave a paper on the procedure of balancing airplane propellers. Army and Navy newsreel pictures were shown at the conclusion of the meeting.

Louisiana State University

The Branch plans to continue its activities through the summer, since the next semester will follow without any vacation interlude this year, and a new meeting room for its permanent use has been acquired. The Branch recently provided judges for a model contest sponsored by the Young Men's Business Club of Baton Rouge. The Annual Banquet of the Branch was held on March 19. An outing is planned to take place at the Home of Ernest Maser, recently elected Honorary Chairman and faculty adviser. New Branch officers elected in April are: Chairman—Charles Cline; Vice-Chairman—Osce Jones; Secretary-Treasurer—Charles Hanson.

Massachusetts Institute of Technology

At a meeting held on April 24 the following officers were elected: Chairman—Benjamin F. Wilbour; Vice-Chairman—Rodney H. Smith; Secretary-Treasurer—Ernest M. Spear; Activities Manager—Robert L. Lichten.

North Carolina State College

Motion-picture films on airplane performance were shown by Prof. R. F. Rautenstrauch of the Aeronautics Department at a meeting held on April 7. At the same meeting the following officers were elected: Chairman—N. G. Geluso; Vice-Chairman—G. E. Langley; Secretary-Treasurer—W. G. Graves; Alternate to the Engineer's Council—A. C. Spruill. Prof. L. R. Parkinson spoke to the Branch on April 14 on the problems of air transportation. The talk was illustrated by slides and was followed by a technicolor sound film furnished by the Aluminum Company of America, entitled *Unfinished Rainbows*. A "Spring Frolic" was held on April 18 in honor of the graduating senior members and the new officers of the Branch.

Ryan School of Aeronautics

On May 1 the Ryan School Branch suspended its activities "for the duration" due to the fact that the Engineering School has been closed and its facilities taken over for the use of a project sponsored by the University of California and the Federal Government to give three-month drafting courses. The project will be under the direction of Stanley H. Evans, former faculty adviser and Honorary Chairman of the Branch. This Student Branch has been active ever since its establishment in January, 1941. Its members will continue their affiliation either as Student Members in other Branches or as Technical Members of the Institute.

Wayne University

At a meeting on April 7 a motion-picture film on the Bell Airacobra and a film on the Messerschmitt Me 110, loaned by Vultee Aircraft, was shown. Officers were elected as follows: Chairman—Myer Klein; Vice-Chairman—Byron Traeger; Treasurer—Morris Levine; Librarian—Walter Kapryan; Chairman of Motion Picture Committee—Robert Cooper. Wilbur L. Ebeling, who acts as faculty sponsor and Honorary Chairman for the Branch, gave a short talk on the advantages of Institute membership. The motion picture *Look to Lockheed for Leadership* was shown at the meeting on April 24 and Mr. Claude Gage, liaison officer at Briggs Mfg. Company, gave a talk on "From Automobile to Aircraft."

Change of Address Notices

In order not to miss issues of the JOURNAL OF THE AERONAUTICAL SCIENCES and the AERONAUTICAL ENGINEERING REVIEW members and subscribers who are planning to change their mail addresses should, whenever possible, notify the Institute of such change thirty days before the mailing date of the issue that is to be sent to the new address—that is, if the August

issue is to be mailed to a new address, the Institute should be notified by July 15. Address changes that are not received in time cause considerable delay in the receipt of magazines, as they must be returned by the post office and additional postage paid for forwarding.

If a change in address also involves a change in a member's place of work, information as to new position or company will be appreciated in order that biographic records may be kept up to date and a note published in "News of I.Ae.S. Members."

Medal to General Doolittle

The award of the Congressional Medal of Honor to Brig. Gen. James H. Doolittle by President Roosevelt on May 19 revealed for the first time details of the April 18 raid on Japanese cities by a squadron of U.S. Army Air Force B-25 bombers and the fact that it was led by General Doolittle.

A Fellow and Past-President of the Institute of the Aeronautical Sciences, "Jimmy" Doolittle's achievements as a pilot and aeronautical engineer are well known to members and all others in aviation. A flying and engineering officer in the Army air services since 1917, he resigned in 1930 with a commission as Major in the Air Corps Reserve to become Aviation Manager of Shell Oil Co. He was recalled to active duty in July, 1940, during his term as President of the Institute, to assist in the expansion of the Army's aircraft procurement program. General Doolittle holds the degree of Doctor of Science from Massachusetts Institute of Technology and the honorary degree of Doctor of Engineering from Polytechnic Institute of Brooklyn and has been awarded the Distinguished Flying Cross with Oak Leaf Cluster, and the Schneider, Mackay, Harmon, Bendix and Thompson trophies. Announcement of his promotion from Lieutenant Colonel to Brigadier General was made on April 23, five days after the spectacular raid on Japan, but his participation in it was kept secret until the award by President Roosevelt a month later.

Announced at the same time was the award of the Distinguished Service Cross to 79 of the airmen who took part in the raid. The following citation was read by Gen. George C. Marshall, Army Chief of Staff, at the presentation of the Congressional Medal of Honor to the leader of the flight:

"Brig. Gen. James H. Doolittle, United States Army, for conspicuous leadership above and beyond the call of duty, involving personal valor and intrepidity at an extreme hazard to life. With the apparent certainty of being forced to land in enemy territory or to perish at sea, General Doolittle personally led a squadron of Army bombers manned by volunteer crews in a highly destructive raid on the Japanese mainland."

General Doolittle's report on the action is a historic document and is given here as released by the War Department:

"The success of the recent air raid on Japan exceeded our most optimistic expectation. Each plane was assigned specific targets and the bombardiers carried out their expert duties with remarkable precision. Since the raid was made in fair weather in the middle of the day and from a very low altitude, no trouble whatever was experienced in finding the exact targets designated.

"Apparently there was no advance warning of the raid, as we experienced little hostile reaction. Not more than thirty Japanese pursuit planes were observed during the flight and these were completely ineffective. Several, we know, were shot down—possibly more. Incidentally, the pilots of these planes seemed somewhat inexperienced, evidently not up to the standards of those encountered in active theatres.

"We approached our objectives just over the housetops, but bombed at 1,500 feet. The target for one plane was a portion of the navy yard south of Tokyo, in reaching which they had passed over what apparently was a flying school, as there were a number of planes in the air. One salvo made a direct hit on a new cruiser or battleship under construction. They left it in flames.

"After releasing our bombs we dived again to the treetops and went to the coast at that altitude to avoid anti-aircraft fire. Along the coastline we observed several squadrons of destroyers and some cruisers and battleships. About twenty-five or thirty miles to sea, the rear-gunners reported seeing columns of smoke rising thousands of feet in the air.

President Roosevelt confers the Congressional Medal of Honor upon Brig. Gen. James H. Doolittle in ceremonies at the White House on May 19, attended by Mrs. Doolittle and Lt. Gen. H. H. Arnold.

"One of our bombardiers strewed incendiary bombs along a quarter of a mile of aircraft factory near Nagoya. Another illuminated a tank farm. However, flying at such low altitudes made it very difficult to observe the result following the impact of the bombs. We could see the strike, but our field of vision was greatly restricted by the speed of the plane and the low altitude at which we were flying.

"Even so, one of our party observed a ball game in progress. The players and spectators did not start their run for cover until just as the field passed out of sight.

"Pilots, bombardiers and all members of the crew performed their duties with great calmness and remarkable precision. It appeared to us that practically every bomb reached the target for which it was intended.

"We would like to have tarried and watched the later developments of fire and explosion, but even so we were fortunate to receive a fairly detailed report from the excited Japanese radio broadcasts. It took them several hours to calm down to deception and accusation."

Later, General Doolittle expanded on this statement somewhat at his press conference held at the War Department. He revealed that the attack had been conducted with North American B-25 medium bombers, especially equipped for the task, and that the volunteer crews had been trained in the United States, had practiced their plan of attack for weeks before it was carried out, but did not know what their exact mission would be until they were ready to take off. The general said that he could not reveal the place of take-off or the landing place and declined to say how many planes had been involved.

News of I.Ae.S. Members

Major Henry A. Berliner, F.I.Ae.S., has reported for duty with the Army Air Forces. He resigned from the presidency of Engineering & Research Corp., which he had headed since 1930, being succeeded by L. A. Wells, former Vice-President and General Manager.

B. G. Bromberg, Chief of the Stress Department of Ryan Aeronautical Co. for the past year, has joined the staff of Vultee Aircraft, Inc., as a Stress Engineer.

The Combat Instruments Advisory Committee, recently formed in the Bureau of Industry Advisory Committees of the War Production Board, includes in its membership **Victor E. Carbonara,** A.F.I.Ae.S., Vice-President and Works Manager, Kollsman Instrument Division of Square D Co.

Walter M. Davies, formerly an Aeronautical Draftsman with the Airplane Division, Curtiss-Wright Corp., is now with Globe Aircraft Corp.

Charles Healy Day, A.F.I.Ae.S., aeronautical engineer and well known as the founder and manager of aircraft manufacturing plants for the Chinese government from 1934 to 1940, has been commissioned a Major in the U.S. Army Air Forces.

Ensign Frank F. Davis, U.S.N.R., formerly of the Engineering Dept. of United Air Lines Transport Corp., is on active duty at a Naval Air Station on the West Coast.

E. W. Dichman, A.F.I.Ae.S., a Major in the Army Specialist Corps Reserve, Manager of Sales and Services for Vought-Sikorsky Aircraft Division, United Aircraft Corp., since 1936, is on active duty with the Materiel Division of the Army Air Forces. He was a flying officer in the Air Service in World War I and an engineering officer at McCook and Kelly fields until 1929, after which he became Chief Engineer of Fairchild Aviation Corp. and then joined the engineering staff of United Aircraft in 1932.

Albert W. Dunning, M.I.Ae.S., has been transferred from Sales Department, Aviation Division of the Monsanto Chemical Co., to aviation development in the company's Plastics Division.

Lloyd S. Dysland is now an Associate Structural Engineer at the Norfolk Navy Yard. He was formerly an Engineering Trainee at Lockheed Aircraft Corp.

Frederick P. Eade has left the Aeronautical Engineering Department of Purdue University to join the staff of the 29 Palms Air Academy.

Transcontinental & Western Air, Inc., announced on April 25 the resignation of **L. G. Fritz,** M.I.Ae.S., Vice-President in charge of Operations, to fill a responsible post in operations for the Ferrying Command of the Army Air Forces.

J. P. Donald Garges, M.I.Ae.S., formerly Project Engineer with Grumman Aircraft Engineering Corp., has been appointed Chief Engineer of Bristol Aeronautical Corp. at New Haven, Conn.

Ensign William V. Gough, Jr., who was stationed at Cavite Naval Base before the entry of the United States in the War, recently sent in his new mail address and asked that greetings be extended to his fellow members of the Institute. He is on duty at sea with the Pacific Fleet.

Carl E. Hall has left Lockheed Aircraft Corp., where he was a Junior Stress Analyst, to become an Engineer with Goodyear Aircraft Corp.

Lt. A. J. Milton Hamon, M.I.Ae.S., is on leave from his post as Assistant Aviation Manager for Shell Oil Co. to serve in Foreign Air Intelligence, Bureau of Aeronautics, Navy Department, Washington.

John Harding, Jr., A.F.I.Ae.S., who was until recently Sales Engineer for Pump Engineering Service Corp., has established his own organization, Harding Devices Co., at Dallas, Tex. The company will be engaged in the design and development of aircraft accessories.

Design of the projected Idlewild Airport to be constructed by New York City in the Borough of Queens will be headed by **Emil K. Harvey,** A.F.I.Ae.S., as Chief of the Design Section. He was formerly Director of the Airport Division of Haller Engineering Associates, Inc.

Dayton representative of North American Aviation, Inc., is **Stanley C. Hellman,** previously in the company's Stress Department.

At its Medal Day Meeting on April 15, The Franklin Institute of Philadelphia awarded its highest honor, The Franklin Medal, to **Dr. J. C. Hunsaker,** Hon.F.I.Ae.S., Past-President of the I.Ae.S., Chairman of the National Advisory Committee for Aeronautics. Dr. Hunsaker is on leave from Massachusetts Institute of Technology, where he was Head of the Department of Mechanical Engineering. The Franklin Medal is awarded annually "to those workers in physical science or technology whose efforts have done most to advance a knowledge of physical science or its application."

At the same meeting presentation of the Franklin Institute's Edward Longstreth Medal was made to **Charles M. Kearns, Jr.,** M.I.Ae.S., Project Engineer, Hamilton Standard Propellers Division, United Aircraft Corp. The Longstreth Medal is awarded "for inventions of high order and for particularly meritorious improvements and developments in machines and mechanical processes." Mr. Kearns was the recipient of The Lawrence Sperry Award conferred by the I.Ae.S. for 1939.

Curtiss-Wright Corp. announced on April 29 the appointment of **S. Paul Johnston,** A.F.I.Ae.S., as manager of the company's Washington office. Since January, 1940, he had been Coordinator of Research for the N.A.C.A. and prior to that was Editor of *Aviation*, with which he had been associated since 1931.

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MOLY

Formerly an Assistant Aeronautical Engineer in the Experimental Engineering Section at Wright Field, **Joseph Kelley, Jr.,** has been commissioned a 2nd Lieutenant in the Army Air Forces and assigned to the Materiel Center at Wright Field.

J. H. Kindelberger, F.I.Ae.S., President of North American Aviation, Inc., is President of the Aircraft War Production Council organized by a group of eight major aircraft manufacturers in southern California "for the purpose of exchanging information and pooling facilities to speed production." Richard W. Millar, President of Vultee Aircraft, Inc., is Vice-President of the Council. Other members of the governing board are **Donald W. Douglas,** H.F.I.Ae.S., President, Douglas Aircraft Co.; **Robert E. Gross,** M.I.Ae.S., President, Lockheed Aircraft Corp.; Harry Woodhead, President, Consolidated Aircraft Corp.; LaMotte T. Cohu, Chairman of the Board of Northrop Aircraft, Inc.; T. Claude Ryan, President, Ryan Aeronautical Co.; Courtlandt S. Gross, President, Vega Aircraft Corp.

Seven functional committees have been formed by the Council to make excess machine capacity of any company available to others, to interchange materiel to avoid a possible production delay because of critical shortage, to exchange engineering and research data and thereby speed solution of problems arising from intensified production, and to make all Council findings and data available to any war industry or Government agency. Chairman of the Engineering and Standards Committee is **Mac Short,** F.I.Ae.S., Vice-President—Engineering, Vega Aircraft Corp.

Otto C. Koppen, F.I.Ae.S., Professor of Aeronautical Engineering at Massachusetts Institute of Technology, has been re-elected Vice-President and a Director of General Aircraft Corp.

Lt. Leo J. Kujawa, formerly Executive Field Engineer for the Parker Appliance Co., has been on active duty with the Army Air Forces for the past several months as Assistant to A.S.C. Liaison Officer for the Central Procurement District.

C. J. Lemonier, M.I.Ae.S., recently Assistant Chief Engineer of Fleetwings, Inc., has joined the Airplane Division, Curtiss-Wright Corp., as a Project Engineer.

Francis Lieber, M.I.Ae.S., has been appointed Chief Engineer of All American Aviation Corp. He was on the engineering staff of Aero Insurance Underwriters and had recently served as a Test Pilot for Bell Aircraft Corp.

Charles A. Lindbergh, F.I.Ae.S., joined the staff of Ford Motor Co. in April to act as consultant on the program for the mass production of bombers at Ford's new plant.

George A. Doole, M.I.Ae.S., Operations Manager and Chief Pilot of Aerovias Nacionales de Colombia (AVIANCA) receives the certificate of the Inter-American Safety Council award from the President of AVIANCA, Dr. Martin del Corral (left), in the presence of Colombian Minister of War Dr. Gonzalo Restrepo (center) at Bogota. The award was presented for the airline's 1941 performance record of 12,973,493 passenger miles and 2,083,106 route miles flown without accident. Four other American airlines receiving awards from the Inter-American Safety Council at the same time were Compania Mexicana de Aviacion, Compania Nacional Cubana de Aviacion (CUBANA), Pan American-Grace Airways (Panagra), and the Western Division of Pan American Airways System.

Major Philip D. Lucas, M.I.Ae.S., formerly Ground School Supervisor for the Civilian Pilot Training Program of the C.A.A. and now on active duty in the Army Air Forces, is Assistant Executive Officer of Tyndall Field.

Lt. Comdr. Carl F. Luethi, U.S.N.R., is on leave of absence from Northwest Airlines and has been stationed at a Naval Air Station on the West Coast.

Lt. Col. Sidney F. Mashbir, M.I.Ae.S., President of the Washington Institute of Technology, is on leave of absence for active duty with the Office of the Chief Signal Officer, War Department, Washington.

Thomas J. May, formerly a Stress Engineer with Vultee Aircraft, Inc., has been commissioned a Lieutenant in the Army Air Forces.

Allen H. McCormick is employed as an Assistant Mechanical Engineer at Wright Field. He had previously been in the Experimental Assembly Department of Pratt & Whitney Aircraft Division, United Aircraft Corp.

Ensign James W. Neighbours, a graduate of Massachusetts Institute of Technology, is attached to the Aerology Section, Bureau of Aeronautics, Navy Department, in Washington.

R. B. C. Noorduyn, A.F.I.Ae.S., has been re-elected Vice-President and General Manager and a Member of the Board of Directors of Noorduyn Aviation Ltd.

George A. Page, Jr., F.I.Ae.S., former Chief Engineer of the Curtiss-Wright Corp., St. Louis Plant, and Codirector of Engineering for the Airplane Division, has been appointed Director of Engineering for the entire Division. He has been with the Curtiss-Wright organization since 1923.

Roland Palmedo, M.I.Ae.S., Lt. Commander, U.S.N.R., has been appointed Head of the Priorities Section, Bureau of Aeronautics, Navy Department.

Recently employed as Design Engineers by the Emerson Electric Mfg. Co. are **E. A. Polowniak,** formerly Draftsman, The Glenn L. Martin Co., **Arthur D. Preston,** Aircraft Inspector, Consolidated Aircraft Corp., and **Philip C. Wright,** Junior Inspector at Consolidated.

Walter C. Posten has been transferred from maintenance with the Pacific Division of Pan American Airways System to the Eastern Division at Miami.

David A. Richardson has left the Curtiss Propeller Division, Curtiss-Wright Corp., to join Aeroproducts Division, General Motors Corp. as an Engineer.

David Schaffer, formerly Junior Aeronautical Engineer with the N.A.-

C.A., has become a Design Engineer with Continental Motors Corp.

C. R. Smith, M.I.Ae.S., who has resigned from the presidency of American Airlines to accept a commission as Colonel in the Army Air Forces, has been appointed executive in charge of plans and operations for the A.A.F. Ferrying Command. Colonel Smith began his career in air transportation in 1928 as Treasurer of Texas Air Transport and continued with the expansion of air transportation in that region to become Vice-President in charge of the Southern Division of American Airways in 1930. When the company was reorganized in 1934 as American Airlines, he was elected President and directed the program of expansion and re-equipment which was started at that time. A. N. Kemp, a Member of the Board of Directors of American Airlines, has been elected to succeed Colonel Smith as President.

Among its engineering staff members honored recently by General Electric Co. for outstanding accomplishment in aircraft supercharger development was **Chester Warren Smith,** M.I.Ae.S., Technical Supervisor of the Supercharger Department.

2nd Lt. Donald M. Thompson, Army Air Forces, has been assigned to the Design Development Section at Wright Field. He was formerly a Stress Analyst with Fleetwings, Inc.

David B. Thurston has left the Experimental Design Department of Vought-Sikorsky Aircraft Division, United Aircraft Corp., and is now a Design Engineer with Grumman Aircraft Engineering Corp.

Ralph M. Tuttle, M.I.Ae.S., has joined Allied Aviation Corp. as a Structures Engineer. He previously held a similar position with Republic Aviation Corp.

Randolph C. Walker, M.I.Ae.S., President of Aircraft Accessories Corp., has taken personal charge of activities at the affiliated Aircraft Accessories Corp. of Missouri as General Manager.

John C. Waller, formerly Instructor in the Training School of United Air Lines, is now a 1st Lieutenant in the Field Artillery, U.S. Army.

Kenneth E. Ward, M.I.Ae.S., has been transferred from Experimental Engineer to Aerodynamicist on the staff of Consolidated Aircraft Corp.

N. F. Ward, A.F.I.Ae.S., has joined Beech Aircraft Corp. as Senior Methods Engineer. He had been Associate Professor of Mechanical Engineering at the University of California from 1927 to 1941, Visiting Lecturer on Metallurgy and Welding for the Boeing School of Aeronautics and, more recently, Process Standards Engineer for Boeing Aircraft Co.

C. R. Smith

On May 15 President Roosevelt defined the membership of **Edward P. Warner,** F.I.Ae.S., on the National Advisory Committee for Aeronautics as representing the Civil Aeronautics Authority. As a member of the Civil Aeronautics Board, he replaces Brig. Gen. Donald H. Connolly on the N.A.C.A. since the latter's resignation as Civil Aeronautics Administrator. His unexpired term, ending December 1, 1946, as a civilian member of the N.A.C.A. will be filled by **T. P. Wright,** F.I.Ae.S., Assistant Chief of the Aircraft Branch, War Production Board.

Rahland C. Zinn has transferred from Project Engineer, Pan American Airways System, to Assistant Maintenance Engineer, Panair do Brasil at Rio de Janeiro.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

Transferred to Associate Fellow Grade

Forman, George Robert, B.S. in M.E.; Editor, Aeronautical Engineering Review; Asst. Treas., Institute of the Aeronautical Sciences.

Nelson, Wilbur Clifton, M.S. in Ae.E.; Asst. Prof. in charge Aero. Engineering, Iowa State College.

Elected to MEMBER Grade

Ebel, Isabel C., Ae.E.; Chief of Stress Dept., Aero. Div., Snead & Co.

Gauvain, William E., Ae.E., Assoc. Aero. Engineer, U.S. Naval Air Station.

Greene, Leonard, Ph.D.; Aerodynamicist, Grumman Aircraft Engineering Corp.

Harcum, William M., B.S.; Project Engineer, Sperry Gyroscope Co.

Hochfeld, Henry, M.E.; Aero. Engineer, Engineering & Research Corp.

Hulse, Barton Traver, B.S.; Chief Test Pilot (for Plant), Airplane Div., Curtiss-Wright Corp.

Jenkins, Edward Summers, S.B.; Plant Chief, Materials & Structures Research, Airplane Div., Curtiss-Wright Corp.

Kallis, Felix, B.S. in M.E.; Aero. Engineer, Assembly & Repair Dept., U.S. Naval Air Station.

Korsak, Kazimierz, Ae.E.; Project Engineer, de Havilland Aircraft of Canada, Ltd.

Pearce, Wilfred, B.S. in G.E.; Structures Engineer, Boeing Airplane Co.

Randolph, Donald Wolf, B.S. in M.E.; Chief Engineer, Apex Electrical Mfg. Co.

Russell, Howard Willis, Ph.D.; Chief Physicist, Battelle Memorial Institute (see A.M. of S.).

Shoults, David Roy, B.S. in E.E.; Engineer, Aviation Div., Industrial Engineering Dept., General Electric Co.

Stephens, Roma Lee, Chief, Flight Engineering & Factory Inspection Branch, 5th Region, C.A.A.

Tchemessoff, Serge, B.S. in Ae.E.; Engineer in charge of Structures, Aviation Div., Ford Motor Co.

Viteles, Morris Simon, Ph.D.; Prof. Psychology, Univ. Pennsylvania; Chairman, Committee on Selection and Training of Aircraft Pilots, National Research Council.

Waller, Jason J., B.E.; Engineer, Fairchild Aircraft Ltd. Canada.

Wildhack, William August, M.S.; Assoc. Physicist, National Bureau of Standards.

Willson, Abner R., E.E.; Electrical Research Eng. (Structural Test Unit), Boeing Aircraft Co.

Zimmerman, Harry Johnson, Chief Pilot, Atlantic Div., TWA, Inc.

Transferred to MEMBER Grade

Bromberg, Ben George, M.S.; Stress Engineer, Vultee Aircraft, Inc.

Del Mar, Bruce Eugene, B.S. in M.E., Cabin Supercharging Engineer, Douglas Aircraft Co.

DuBuque, Jean Howard, Capt., U.S.A.; Squadron Commander, Air Svc. Command, Air Corps.

Smithline, Lawrence Nathaniel, M.-

Ae.E.; Chief Engineer, Langley Aviation Corp.

Westphal, George Waldermar, B.S. in Ae.E.; Chief Stress Analyst, Waco Aircraft Co.

Elected to Industrial Member Grade

Bowman, Leslie Harold, Pres. & Gen. Mgr., Aircraft Sales Co.

de Souza, José Garcia, Technical Director, Companhia Nacional Navegação Aerea, Brazil.

Ternes, Raymond Francis, LL.B.; Patent Engineer, United States Rubber Co.

Elected to Technical Member Grade

Benneck, Conbert Hans, Repairman, Kollsman Inst. Div., Square D Co.

Bricker, Ethelbert Irvin, M.S. in Ae.E.; Research Asst., State Engg. Experiment Station, Georgia School of Technology.

Brierton, James Lawrence, B.S. in C.E.; Project Liaison Engineer, Airplane Div., Curtiss-Wright Corp.

Bryant, Routt A., Jr., Asst. Group Engineer, Consolidated Aircraft Corp.

Cole, Russell Hammond, Chief Draftsman, Vard Mechanical Lab.

Gilmer, George Walker, III, B.M.E.; Jr. Engineer, Pan American Airways-Africa, Ltd.

Haskell, Clifton Roy, M.E.; Stress Engineer, Aero. Div., Snead & Co.

Haskins, Robert, Jr., M.S.; Asst. Project Engineer, Sperry Gyroscope Co.

Horning, Frederick Wayne, Sr. Design Checker-Engineering, Lockheed Aircraft Corp.

Jungemann, William Clemens, B.S.; Stress Analyst, Consolidated Aircraft Corp.

Knox, Charles Benjamin, Independent Wind Tunnel Research, Hawaii.

LaRosa, Salvatore, Stress Analyst, Aero. Div., Snead & Co.

Manuel, Hermogenes Suico, B.S. in M.E.; Mech. Engineering Draftsman, Francisco & Jacobus.

Platz, Donald Edward, Jr. Engineer, Stress Dept., Aero. Div., Snead & Co.

Rautenstrauch, Robert, M.S. in Ae.E.; Asst. Professor, Aero. Engineering, North Carolina State College.

Rioux, Richard N., B.S. in Ae.E.; Design Engineer, Emerson Electric Mfg. Co.

Schetzer, Julius David, B.S.E.; Stress Engineer, Stinson Aircraft Div., Vultee Aircraft, Inc.

Small, Ramond Edward, B.S. in M.E.; Application Engineer, General Electric Co.

Steinbacher, Franz Russell, B.-Ae.E.; Instructor, Univ. Michigan.

Wagner, Daryl Eugene, Ae.E.; Material Follow-Up, Globe Aircraft Corp.

Warrener, Arthur Edward, Inspector, Clark Ruse Aircraft Ltd., Nova Scotia.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Instructor familiar with airplane design, salary $2,200 a year; **Research Assistant** with no teaching duties, familiar with aerodynamic research, stipend $900 plus income from research work, opportunities for graduate work; **Teaching Assistants** (three) in engine, structural and aerodynamic laboratories, stipend $900 first year, opportunities for graduate work. Location east with large university. Give educational background, professional experience, photograph in letter of application. Address inquiries to Box 150, Institute of the Aeronautical Sciences.

Airplane Designers, Stress Analysts, and Draftsmen needed for few vacancies remaining on engineering staff. At least four years' experience essential. Release will be required if now employed in similar position. (Can also use one or two recent graduates for computation work.) Write for appointment stating education, experience, and salary. Snead & Company, Aeronautical Division, 421 Canal Street, New York, N.Y.

Aeronautical Engineer experienced in plywood aircraft manufacturing wanted by southern aviation company. Must be able to take active charge of manufacturing and engineering operations. State experience and salary expected in first letter. Address Aviation Engineering, Inc., 1390 Blashfield Street, S.E., Atlanta, Ga.

Two Draftsmen, preferably with instrument experience, for work on confidential projects for Army and Navy having vital bearing on the War effort. Applicants must be able to satisfy F.B.I. regarding loyalty prior to starting work. Residence and work will be in small town on Long Island. It is anticipated work will be permanent. Address inquiries to Box 157, Institute of the Aeronautical Sciences.

Candidates for Training in all branches of airline maintenance wanted for courses offered at no expense by major airline. Applicants must have had a few years' mechanical or technical experience along suitable lines and be willing to locate outside the New York area. Address inquiries, giving complete outline of qualifications and experience to Personnel Dept., TWA, La Guardia Field, New York.

AVAILABLE

Aeronautical Engineer (B. of Ae.E.) with five years' experience in aircraft power plant installation design, including layout, supervision, shop contact, liaison, and field work for at least five first-rate military airplanes; also one year of shop experience as mechanic and inspector in aircraft. Desires position in supervisory design capacity or as engineering representative with power plant accessory manufacturer or as group engineer or assistant on power plants with aircraft manufacturer. Address inquiries to Box 155, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Test Pilot desires permanent and responsible position. Extensive aeronautical research and development experience with Government and major aircraft manufacturer. Training, including Master of Science degree, at leading engineering college. Particularly qualified in development and performance flight testing as applied to power plant installation development. Able to solve new engineering problems in practical manner. Inventive ability demonstrated. Location in Southern California preferred. Age 39. Address inquiries to Box 156, Institute of the Aeronautical Sciences.

Graduate Aerodynamicist with five years' diversified experience with major aircraft manufacturers desires new connection in aircraft development or engineering administration. Address inquiries to Box 158, Institute of the Aeronautical Sciences.

Necrology

Kenneth Fey, Student Member of the I.Ae.S. Branch at the University of Detroit, died on May 12, 1942, after an illness of three days. He was born in Fremont, O., and entered the University in September, 1937, following his graduation from St. Joseph's High School there. A member of the Senior Class, he was very active in the affairs of the Student Branch and was also a member of the Tower Club and the Glider Club. He was among the five ranking seniors in aeronautical engineering and would have received the degree of Bachelor of Aeronautical Engineering this June.

Aeronautical Engineering Review

Directory of

Aircraft Products and Services

The companies listed in this directory contribute to the support of the Institute of the Aeronautical Sciences, the Journal of the Aeronautical Sciences and the Aeronautical Engineering Review through Corporate Membership dues or advertising or both.

The Institute will appreciate any consideration that members and subscribers can give to the products or services of these companies. It will be glad to assist in obtaining complete information on listed or any other products or services not included.

AIRCRAFT

Airplane Division (Buffalo Plants), Curtiss-Wright Corporation
Airplane Division (St. Louis Plant), Curtiss-Wright Corporation
Boeing Aircraft Company
Consolidated Aircraft Corporation
Douglas Aircraft Company
Duramold Aircraft Corporation
Engineering & Research Corporation
Fairchild Aircraft Division, Fairchild Engine & Airplane Corporation
Fleetwings, Inc.
Goodyear Aircraft Corporation
Grumman Aircraft Engineering Corporation
Intercontinent Aircraft Corporation
Lockheed Aircraft Corporation
The Glenn L. Martin Company
North American Aviation, Inc.
Northrop Aircraft, Inc.
Republic Aviation Corporation
Ryan Aeronautical Company
Stinson Aircraft Division, Vultee Aircraft, Inc.
Vega Aircraft Corporation
Vought-Sikorsky Aircraft Division, United Aircraft Corporation
Vultee Aircraft, Inc.

AIR TRANSPORTATION

American Airlines, Inc.
Northwest Airlines, Inc.
Pan American Airways System
Transcontinental & Western Air, Inc.
United Air Lines Transport Corporation

ALTIMETERS

Kollsman Instrument Division, Square D Company
Pioneer Instrument Division, Bendix Aviation Corporation

ALUMINUM

Aluminum Company of America

BATTERIES

The B. F. Goodrich Company

BEARINGS

Allison Division, General Motors Corp.
Norma-Hoffmann Bearings Corporation

BOOKS (TECHNICAL)

Aircraft Specialties, Inc.
Bunhill Publications, Ltd.
Chemical Publishing Company
McGraw-Hill Book Company, Inc.
Pan American Navigation Service
Pitman Publishing Corp.

CAMERAS & SUPPLIES

Fairchild Aviation Corporation

CARBURETORS

Bendix Products Division, Bendix Aviation Corporation
Chandler-Evans Corporation

COLLECTOR RINGS

Edward G. Budd Manufacturing Company
Ryan Aeronautical Company
Thompson Products, Inc.

COMPASSES

Bendix Radio Corporation
Fairchild Aviation Corporation
Kollsman Instrument Division, Square D Company
Pioneer Instrument Division, Bendix Aviation Corporation
Sperry Gyroscope Company
Weston Electrical Instrument Company

COMPOUNDS (CLEANING)

Oakite Products, Inc.

CONNECTORS (ELECTRICAL)

Cannon Electric Development Co.

CONTROLS & ASSEMBLIES

Breeze Corporations
Eclipse Aviation Division, Bendix Aviation Corporation
Pacific Scientific Company
Pump Engineering Service Corporation
Simmonds Aerocessories, Inc.
S. S. White Dental Mfg. Company
Sperry Gyroscope Company
Vega Aircraft Corporation

COOLERS (OIL)

Airesearch Manufacturing Company
Edward G. Budd Manufacturing Company
Standard Aircraft Products, Inc.

CORD (SHOCK)

The B. F. Goodrich Company

COWLS

Airplane Division (Buffalo Plants), Curtiss-Wright Corporation
Edward G. Budd Manufacturing Company
Vega Aircraft Corporation

DE-ICER EQUIPMENT

Eclipse Aviation Division, Bendix Aviation Corporation
The B. F. Goodrich Company
Pump Engineering Service Corporation

ELECTRICAL EQUIPMENT

Cannon Electric Development Co.
Struthers Dunn, Inc.

ENGINES

Allison Division, General Motors Corp.
Eclipse Aviation Division, Bendix Aviation Corporation
Guiberson Diesel Engine Company
Jacobs Aircraft Engine Company
Packard Motor Car Company
Pratt & Whitney Aircraft Division, United Aircraft Corporation
Ranger Aircraft Engines Division, Fairchild Engine and Airplane Corporation
Warner Aircraft Corporation
Wright Aeronautical Corporation

FABRICS

Wellington Sears Company

FASTENERS

Boots Aircraft Nut Corporation
Eaton Manufacturing Company
Elastic Stop Nut Corporation
Simmonds Aerocessories, Inc.
Thompson Products, Inc.
Tinnerman Products, Inc.
United Carr Fastener Corporation